EFFECTS OF BIOFEEDBACK GAME ON AFFECTS AND ANXIETY AMONG UNDERGRADUATE STUDENTS

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A RESEARCH PROJECT

SUBMITTED IN

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Effects of Biofeedback Game on Affects and Anxiety among Undergraduate Students

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APPROVAL FORM

This research paper attached hereto, entitled “Effects of Biofeedback Game on Affects and Anxiety Among Undergraduate Students” prepared and submitted by Ling Gong Shuen, Ng Kuan Sien, and Tan Pei Chin in partial fulfillment of the requirements for the Bachelor of Social Science (Hons) Psychology is hereby accepted.

_____ Date: _____

Supervisor

(Mr. Pheh Kai Shuen)

Abstract

This study aimed to investigate the effects of biofeedback game on affection and anxiety among undergraduate students. This study was conducted in an experimental study with pilot randomized controlled trial (RCT) design by using purposive sampling method. The participants are 28 undergraduate students in UTAR who aged from 18 to 22 years old with a mean age of 22 years old (SD = 1.14 for intervention group, SD = 1.33 for control group). The demographic questionnaire was given as serving for quantitative survey. Positive and Negative Affect Schedule (PANAS), State-Trait Anxiety Inventory (STAI) are used to measure the variables in this study. The result revealed that there is a significant difference of the heart rate variability between treatment and the control group at posttest. All of the variables have significant differences between pre and post-test, except for positive affection. The limitation and recommendation of present study are discussed. In conclusion, the present study found little evidence on the effects of biofeedback games in reducing negative affection, anxiety, and improving positive affection.

Keywords: biofeedback game, affect, anxiety, undergraduate students

DECLARATION

We declare that the material contained in this paper is the end result of our own work and that due acknowledgement has been given in the bibliography and references to all sources be they printed, electronic or personal.

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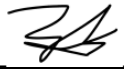
Signed : 

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List of Abbreviations

HR	Heart Rate
HRV	Heart Rate Variability
NA	Negative Affect
PA	Positive Affect
S-anxiety	State Anxiety
T-anxiety	Trait Anxiety

Chapter I

Introduction

Background of study

Biofeedback Games as Treatment and Intervention. Biofeedback is the process to gain physiological functions information by using the instruments to voluntarily influence physiology processes by making changes in cognition to improve the health and performance of an individual as a therapy instrument (Agathon & Mazel, 1999; Schwartz, 1999).

Multiple of researches show that biofeedback-enhanced relaxation training has a significant effect to reduce the level of multiple psychological disorders, including anxiety and depressive symptoms (Brezinka, 2014; Knox et al., 2011; Schuurmans, Nijhof, Engels, & Granic, 2018).

A study suggests that activity in emotion, cardiovascular system, respiratory system is considered highly related to the emotion (Kreibig, 2010). Hence, the change in emotion and anxiety can be measured by using the HR and HRV with biofeedback (Kahn, Ducharme, Rotenberg, & Gonzalez-Heydrich, 2013; Knox et al., 2011). By utilizing the video game-like biofeedback tools, it has been theorized to be able to enhance emotional regulation skills by strengthening the functional connectivity between prefrontal and amygdala networks (Kahn et al., 2013).

The biofeedback game, Villa Serena is a game that is designed to train the breathing cycle to be deeper, slower and more regular while reducing the HR into a resonant frequency commonly referred to as Coherence which also is the state as high HRV with no mentor and no instruction (Wild Divine, n.d.).

Risk of Mental Health Issues among Undergraduate Student in Global and Malaysia. Globally, the university student is the group that consistently showing mental health problem around the world (Adlaf, Gliksman, Demers, & Newton-Taylor, 2001; Bore, Pittolo, Kirby, Dluzewska, & Marlin, 2016; Cuttilan, Sayampanathan, & Ho, 2016; Song et al., 2008; Wintre & Yaffe, 2000; Zivin, Eisenberg, Gollust, & Golberstein, 2009), due to stressors to meet high academic and interpersonal demand (Uehara, Takeuchi, Kubota, Oshima, & Ishikawa, 2010).

In Malaysia, one out of three Malaysian adults have the potential to develop mental health problems (Institute for Public Health, 2011). Research on Malaysia showed that both depression and anxiety are significant among undergraduate students between 18 to 24 years old (Shamsuddin et al., 2013). The emotional disorder is widespread among undergraduate students (Al-Naggar & Al-Naggar, 2012), and expected to keep increasing annually (Zivin et al., 2009). Hence, research for the enhancement of intervention is suggested to overcome the rising anxiety and emotional issues (Shamsuddin et al., 2013). More outreach is also needed to encourage the student to get the treatment (Zivin et al., 2009).

Affect Regulation and Anxiety. The word “emotion”, “affect” and “mood” are usually interchangeable (Ekkekakis & Russell, 2013). Affect can be divided into PA and NA independently with the fusion of different forms such as emotion and mood (Ekkekakis & Russell, 2013). In an average individual with high negative affectivity (NA), such as anger, nervous, contempt, ashamed, disgust, guilt and fear (Koch, Forgas, & Matovic, 2013; Watson & Clark, 1994), are having higher levels of distress, anxiety, and dissatisfaction (Gross, 2002). Relatively, positive affectivity (PA) such as happy, attentive, alert, inspired, enthusiastic and active (Watson & Clark, 1994), are expected to provide multiple benefits (Schenk et al., 2018)

and improve wellbeing (Schwarz & Clore, 1983). Hence, lack of emotion regulation skills can cause high NA and have potential anxiety or emotional, mood disorders (Campbell-Sills, Barlow, Brown, & Hofmann, 2006).

Anxiety has psychiatric and psychological symptoms (Aldao & Nolen-Hoeksema, 2010; Aldao, Nolen-Hoeksema, & Schweizer, 2010), such as affection of uneasiness and worries, and psychological symptoms such as increased HR, breathing rapidly, sweating, trembling, find difficulty in concentrating, and having trouble sleeping (Bouras & Holt, 2017). The increase of PA and reduce NA are expected to lower the anxiety level (Watson, Clark, & Carey, 1988). Undergraduate students were more than half (50.22%) potential cases of anxiety globally (Mirón et al., 2019), and 35.8% in Malaysia (Ithnain, Ezzat Ghazali, & Jaafar, 2018), due to the lacking of emotional regulation skill (Aldao & Nolen-Hoeksema, 2010).

Problem Statement

The lack of affect regulation is an early risk factor for the upgrowth of multiple mental disorders (Izard, Trentacosta, King, & Mostow, 2004). However, there is a lack of studies in general emotion regulation (Hafizah & Hafiz, 2015), and the intervention of emotion regulation in Malaysia university students (Bagheri, Kosnin, & Besharat, 2016). Biofeedback game as mental health interventions is also having limited research (Shah, Kraemer, Won, Black, & Hasenbein, 2018). Hence, there are significantly lacking biofeedback game-related studies in Malaysia due to minor exposure (Noraziah, Suna Abdullah, Aqtar, Adam Ibrahim Fakhreldin, &Abd Wahab, 2015), and no public study can be found on Villa Serena as a tool that has effects on affects regulation and anxiety.

The undergraduate student also usually involved with maladaptive emotion regulation strategies (Sarfan, Cody, & Clerkin, 2019), including using drugs, alcohols (Gross, 2014) and expressive suppression (Neidenthal, Kranth-Gruber, & Ric, 2006; Ramzan & Amjad, 2017) that can bring to multiple negative social consequences (Butler et al., 2003). They are lacking the motivation to change which causes low treatment effectiveness and treatment dropout (Harder, Knorth, & Kalverboer, 2012, 2015).

Although the effectiveness of the biofeedback game as the enhancing tool to reduce the level of multiple psychological disorder has been well established, yet, reviews suggest more diverse samples are needed to be evaluated such as undergraduate students (Shah, Kraemer, Won, Black, & Hasenbein, 2018). This means that, even though promising results show in emotion management, it is still needed for more empirical evaluation (Shah et al., 2018).

Research Objectives

Our research objectives are as below:

1. To determine the effectiveness of Biofeedback Game, Villa Serena on positive affects score.
2. To determine the effectiveness of Biofeedback Game, Villa Serena on negative affects score.
3. To determine the effectiveness of Biofeedback Game, Villa Serena on reducing state anxiety.
4. To investigate the effectiveness of Biofeedback Game, Villa Serena on heart rate.
5. To investigate the effectiveness of Biofeedback Game, Villa Serena on heart rate variability.

Research Question

Our research questions are as below:

1. Does Biofeedback Game, Villa Serena has significant effects on positive affects score?
2. Does Biofeedback Game, Villa Serena has significant effects on negative affects score?
3. Does Biofeedback Game, Villa Serena has significant effects on the level of state anxiety?
4. Does Biofeedback Game, Villa Serena has significant effects on heart rate?
5. Does Biofeedback Game, Villa Serena has significant effects on heart rate variability?

Research Hypothesis

Research question 1:

H_0: Biofeedback Game, Villa Serena does not have significant effects on positive affects score.

H_1: Biofeedback Game, Villa Serena have significant effects on positive affects score.

Research question 2:

H_0: Biofeedback Game, Villa Serena does not have significant effects on negative affects score.

H_1: Biofeedback Game, Villa Serena have significant effect on negative affects score.

Research question 3:

H_0: Biofeedback Game, Villa Serena does not have significant effects on the level of state anxiety.

H_1: Biofeedback Game, Villa Serena have significant effects on the level of state anxiety.

Research question 4:

H_0: Biofeedback Game, Villa Serena does not have significant effects on heart rate.

H_1: Biofeedback Game, Villa Serena have significant effects on heart rate.

Research question 5:

H_0: Biofeedback Game, Villa Serena does not have significant effects on heart rate variability.

H_1: Biofeedback Game, Villa Serena have significant effects on heart rate variability.

Significance of the Study

Variety to encourage students to get the treatment to prevent mental health issues is in demand (Zivin et al., 2009). As the increase of the popularity and economy role of video games (Schilling, 2003), Biofeedback games have the potential to thrive as it can be adapted to various platform and device, such as computers, mobile phone, and gaming platforms, which leads to more undergraduates involve in healthy affects regulation techniques, instead of maladaptive behavior (Gross, 2014).

Besides, integrative of gaming into teaching is a general future trend (Shaffer, Squire, Halverson, & Gee, 2005). There has a researcher suggests that the interest and engagement can be increased to the treatment with facilitate of biofeedback games (Knox et al., 2011), enhance affect regulation skills (Kahn et al., 2013), deep breathing, imagery and relaxation (Knox et al., 2011). The biofeedback games provide the opportunities to the therapist and facilitator able to go with the times and not lacking behind in the era, and increase wellbeing in overall by expanding their chances to self-help affect regulation (Schwarz & Clore, 1983).

Moreover, this research can contribute to empirical evaluation since diverse samples of Biofeedback Game effectiveness are in demand on the ordinary undergraduate student (Shah et

al., 2018). Hence, most of the research is focusing to use the Biofeedback games on emotion disorder patients, the change of target participant to undergraduate student threatening Biofeedback games as a potential early prevention tool to lower the risk of emotion disorder (Izard, Trentacosta, King, & Mostow, 2004). This research also provided a more objective view from the reaction of the cardiovascular system and respiratory system with the references of using a subjective view from self-reported assessments, which can provide fewer bias results and more concrete empirical data.

Conceptual and Operational Definitions of Terms

Affect. Affect is an idea in psychology to describe the experience of emotion and feeling, it's usually interchangeable with "emotion", "affect" and "mood" (Ekkekakis & Russell, 2013). However, generally, core affects used to refer to one of the essential components that constitute a primary emotional unit (Russell & Barrett, 1999). Hence, a fusion of different forms like affect, emotion, and mood in items is shown in PANAS (Ekkekakis & Russell, 2013).

The operational definition of affect will be the self-assessing tool's score on PANAS, which is divided as PA and NA. The higher the score on PA or NA means that they have a higher level of PA or NA, while lower the score on PA or NA means that they have a lower level of PA or NA.

Anxiety. Anxiety is an affection of uneasiness and worries, with psychological symptoms which are increased HR, breathing rapidly, sweating, trembling, and difficulty in concentrating (Bouras & Holt, 2017). Anxiety can be shown as short-term state anxiety or long-term trait anxiety. State anxiety is defined as stimulation of autonomic response and raise of emotions in the State-Trait Anxiety Inventory (STAI), such as the subjective feelings of anxiety, tension, and

fear triggered by specific situational or events with possibilities of risk. Trait anxiety is more towards a long-term personality trait, where a long period in the state of the vulnerability to anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

The operational definition of anxiety is the score on the STAI Anxiety scale. STAI is a self-report assessment tool that scores will be ranging from 20 to 80 in which 20 is considered as low anxiety and 80 is considered as a high anxiety level.

Heart Rate Variability (HRV). HRV is the time interval between heartbeats which is measured by the variation in the beat-to-beat, R–R interval time series, also known as heart period (Kamath, Watanabe, & Upton, 2016; Sasaki & Maruyama, 2014).

The operational definition for HRV is the coherence score that shows on the IOM grapher. The Villa Serena play by getting a high coherence score leads to progress in the game. The Wild Divine IOM active feedback hardware and finger sensor are used for measurement, by connecting the pulse finger sensor to the participant's fingertips to sense pulse rate and do the value of R-R interval calculation by calculating the standard deviation of N-N intervals. The higher the coherence score, the higher the HRV, which also means the improvement of emotional regulation and lower anxiety.

$$R - R\ interval = \frac{60{,}000}{heart\ rate\ (bpm)}$$

Figure 1.1 Formula of heart rate variability, calculating R-R interval from heart rate.

Chapter II

Literature Review

Affection

Numerous past studies depicted a low correlation between PA and NA (Crawford & Henry, 2004; Watson, Clark, & Tellegen, 1988). Thus, PA and NA should be discussed separately in this study. Ma et al. (2017) showed that breathing technique reduces NA and enhances emotions. However, they failed to record its first improvement because of the unstandardized method. Alavi & Jabal Ameli (2018) found that Cognitive-Behavioral Therapy (CBT) can enhance PA. It improved the emotional state and capability to control positive emotions.

Gaetan, Bréjard, and Bonnet (2016) found that playing games regularly do not affect emotion. Regular gamers may have a lower emotional reactivity and have more difficulty to express themselves. Moreover, Affrunti and Woodruff-Borden (2016) pointed out that NA predicts children's anxious and worry symptoms. Children regulate their emotions differently compared with the adults, like language development (Cole, Armstrong, and Pemberton, 2010; Sala, Pons, and Molina, 2014) and demographic differences like genders and ages (Sala et al., 2014).

Collectively, these past studies indicated that affection has a connection with emotional control. Therefore, researchers should place their focus on controlling emotion and study each aspect of affection independently.

Anxiety

Hassan, Hassan, Kassim, and Hamzah (2018) discovered that mental health issues, especially depression and anxiety, are the most prevalent among adolescents and low-income groups in Malaysia. Shamsuddin et al. (2013) also found that anxiety level is higher among the older university students and significantly correlated to socioeconomic status. Specifically, the older adolescent has a higher possibility to develop some mental issues than younger ones because of academic goals (Beiter et al., 2015) and time management (Kumaraswamy, 2013).

In our society, many techniques are spreading and need to investigate. For instance, breathing exercises (Fenn & Byrne, 2013) and meditation (Jerath, Crawford, Barnes, and Harden, 2015) may help in coping with anxiety symptoms. These practices were also used in anxiety-related disorders and showing a positive result. CBT intervention is effective in alleviating anxiety symptoms and others, such as irrational beliefs and negative beliefs (Popa and Predatu, 2019). It is supported by Alavi and Jabal Ameli (2018) on patients who suffered from the damage of the central nervous system. Sadipun, Dwidiyanti, and Andriany (2018) used mindfulness intervention to examine emotional control. The result showed that anxiety is reduced by decreasing the production of anxiety-related hormones. Emotional control makes a vital predictor at predicting anxiety symptoms (Bos, Diamantopoulou, Stockmann, Begeer, and Rieffe, 2018; Brockman, Ciarrochi, Parker, and Kashdan, 2017; Pačarić, Nemčić, Farčić, & Trazer, 2018).

Collectively, these past studies focused on mentally ill patients are insufficient for modern needs. Therefore, it is critical to study anxiety in general societies. Hence, it will be more relevant for the public to become more aware of their mental health.

Biofeedback Game and Affection

Physiological responses can be used to measure affection, such as HR, breathing rate, and blood pressure (Kop et al., 2011). Therefore, a biofeedback device is vital to detect those responses in a biofeedback game. For instance, Fagundo et al. (2013) used video game therapy to examine its effect on patients with Bulimia Nervosa. It showed an improvement in emotional regulation and impulsivity control after the treatment. Kahn, Ducharme, Rotenberg, and Gonzalez-Heydrich (2013) incorporated video game with CBT. The anger feelings and anger intensity decreased significantly in the videogame intervention group. During the game-play, it also improved HR control and the ability to control emotions.

In summary, these studies focus on regulating emotions through gaming experiences of biofeedback games. Games provide an opportunity to practice emotional regulation skills, so they will have to introspect themselves for the most suitable strategy to regulate their emotions. Besides, self-report measures help past researchers to visualize the inner state of individuals, such as emotions and thoughts. Hence, the selection of games and self-report make a difference in the result of the study.

Biofeedback Game and Anxiety

Biofeedback games play an important role in study anxiety as its severity varies in level. Schuurmans, Nijhof, Engels, and Granic (2018) investigated the effectiveness of the biofeedback game on young adolescents. It showed the game reduces their anxiety for the short-term only. Furthermore, Knox et al. (2011) also found that biofeedback game intervention can reduce

anxiety symptoms. Similarly, Yahav and Cohen (2008) conducted a study in which the intervention groups showed a decrease in state anxiety. However, trait anxiety is not included.

In contrast, Dennis and O'Toole (2014) reported there is no significant difference in self-rated anxiety. However, the findings remain inadequate as there is no biofeedback device included in the study. Schoneveld et al. (2016) found that both children and parents reported a decrease in anxiety. Emotional states like anxiety may affect respiration rate and skin temperature at different difficulty levels in the game (Chanel, Rebetez, Bétrancourt, and Pun, 2008; Liu, Agrawal, Sarkar, and Chen, 2009). Furthermore, Fagundo et al. (2013) found that Island videogame can reduce anxiety. It indicates an improvement in the executive control of emotion.

Collectively, these studies depicted the biofeedback game can trigger anxiety in different difficulty levels and in any situation, whether the attention is direct away or towards the anticipated threats. Externalizing behaviors such as anxious acts can be reduced by using relaxation training to reduce tension in game play.

Biofeedback Game and Heart Rate Variability (HRV)

Fagundo et al. (2013) conducted a study in which the improvement of HRV may indicate the control over the eating disorder. In general, HRV, or coherence score helps to interpret the fluctuations of HR but is not often mentioned. Besides for coherence score, certain aspects such as age, cardiac status, and exercise habits should be acknowledged because they could affect the frequency and intensity of HR.

Theoretical Framework

Behavior Analysis. It defines that our behaviors can be modified. For instance, classical conditioning and operant conditioning are well-known for their practical use in various fields. In our study, we apply positive reinforcement to achieve the outcome. Positive reinforcement works well if a reward is given right after the desired behavior is performed. It is to strengthen and increase the recurrence of desired behavior in the future.

Breathing technique, or mindfulness breathing, is described as controlling respiration rate and breath takes (Ma et al., 2017), which can influence our emotions. A person who practices breathing techniques is more willing to face negative stimuli and can reduce their negative emotions (Arch and Craske, 2006).

In this study, the use of the breathing technique is reinforced by using the sense of progression in the game and the coherence score as rewards. As the game player senses the game is progressing as he or she wants, he or she will be more willing to control the rhythm of deep breathing. When the breathing technique is applied, the respiration rate decreases and thus results in decreasing HR. When HR decreases, the player can continue to play the game as the progress acts as a reward to reinforce the usage of breathing technique. A positive feedback loop thus develops.

Conceptual Framework

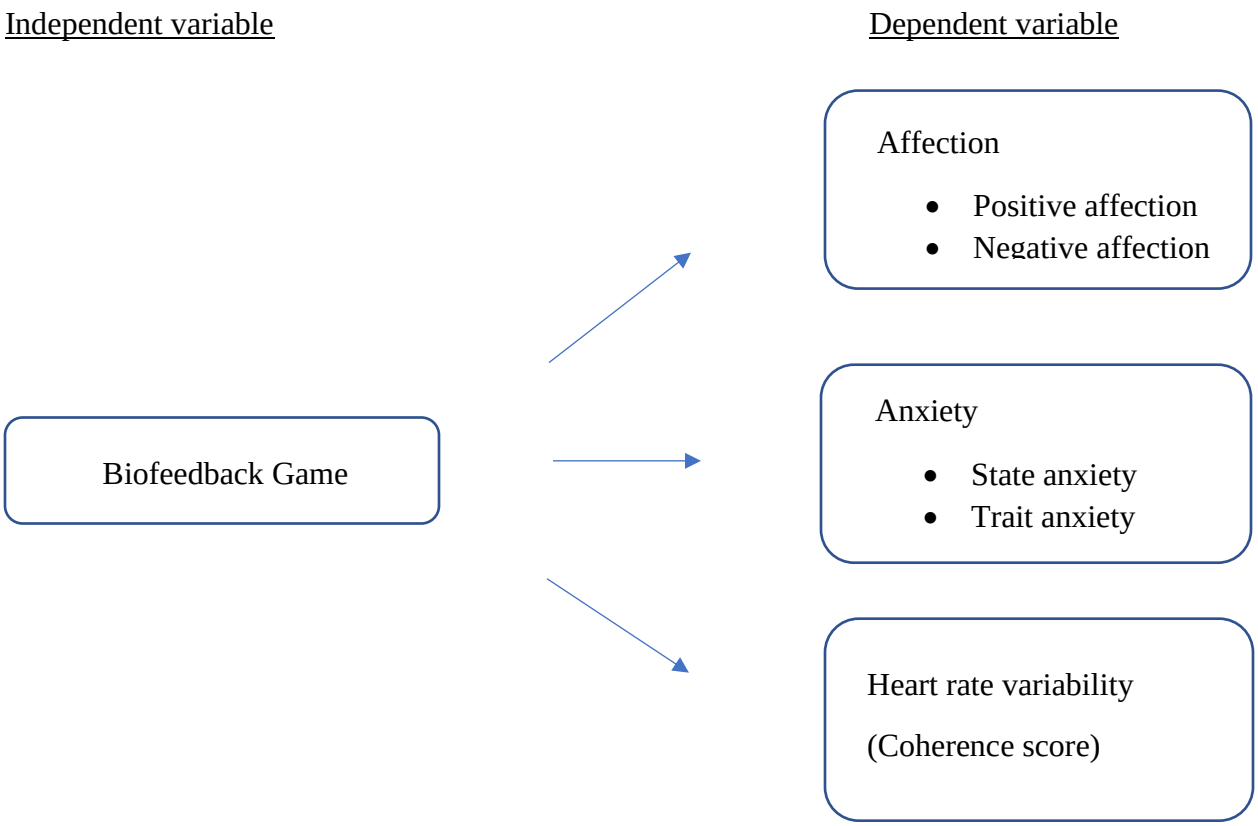

Figure 2.1 Conceptual framework of biofeedback game on affection, anxiety, and heart rate variability (coherence score).

This study has one independent variable, which is biofeedback game. It is applied to analyze its effect on the three dependent variables. The first variable is affection. It divided into PA and NA stated on the PANAS scale. Secondly, anxiety in which the state anxiety and trait anxiety are being measured. State anxiety is a spontaneous response of anxiety whereas trait anxiety is a personality trait of anxiousness. Thirdly, HRV or coherence score measures the

fluctuation of circadian cycle and blood pressure to a certain extent. Their relationship is as shown above (Figure 1).

This study is to investigate the effectiveness of breathing techniques on affection, anxiety, and HRV through the biofeedback game. As the target participants are undergraduate students, the theory of behavior analysis is applied consciously so that they can observe the behavioral changes through the gameplay session. In general, this study is aimed to understand the impact of breathing techniques and the implications in real-life situations.

Chapter III

Methodology

Research Design

An experimental research design with pilot randomized controlled trial (RCT) design was employed in this study to determine the effects of a biofeedback game on undergraduate students' PA and NA as well as anxiety levels. This study was conducted as a pilot study to examine the feasibility of Villa Serena as an intervention for emotion regulation and anxiety reduction among undergraduate students. RCT design is a study in which the participants are randomly distributed into either intervention or control group (Akobeng, 2005; Kendall, 2003). This design was employed to compare the outcomes of study to determine the effectiveness of intervention (Kendall, 2003) as well as eliminate selection bias and reduce the confounding factors to increase the accuracy of the study's results (Akobeng, 2005). Moreover, single-blind was applied in this study. Single-blind refers to a situation where participants are blocked from perceiving the details of the study they participate (Akobeng, 2005). The purpose was to avoid the participants from being affected by the knowledge of study which may lead to biased results (Akobeng, 2005).

Research Sample

The population for this research study involved all of the undergraduate students in the Universiti Tunku Abdul Rahman (UTAR) Kampar campus. Purposive sampling, which is a non-probability sampling method, was utilized to recruit the sample. Purposive sampling is a way of selectively involving people with certain characteristics based on the study's aim to obtain

desirable data to the study (Etikan, Musa, & Alkassim, 2016). The inclusion criteria were undergraduate students who ranged from 18 to 24 years old. The exclusion criteria were those students with cardiovascular disease.

According to Julious (2005), the rule of thumb suggested that a sample size of 12 is applicable for a pilot study. This sample size's justifications were depending on the rationale of feasibility, precision about mean and variance, and regulatory considerations (Julious, 2005). There were a total number of 28 undergraduate students recruited in this study. All participants were randomly and equally allocated into either intervention or control group by using an online random sequence generator. Thus, both intervention and control group involved 14 participants respectively. The intervention group comprised five males and nine females whereas the control group comprised three males and 11 females. Both intervention and control groups had the same average age of 22 years old. Table 3.1 below illustrates the demographic data of participants, including their genders, ethnicities, year of study, faculties and courses they are studying.

Table 3.1

The Demographic Data of The Participants in Intervention and Control Group

	Intervention Group	Control Group
Mean Age (SD)	22 (1.14)	22 (1.33)
Gender		
Male	5	3
Female	9	11
Ethnicity		
Chinese	14	14
Year of Study		
Year 1	2	2
Year 2	1	4
Year 3	9	7
Year 4	2	1
Faculty		
FAS	9	11
FBF	1	2
FEGT	1	0
FICT	2	1
ICS	1	0
Course		
Advertising	1	1
English Language	0	4
Guidance and Counselling	1	1
Journalism	0	1
Psychology	6	4
Public Relations	1	0
Banking and Finance	0	1
Entrepreneurship	1	0
Financial Economics	0	1
Construction Management	1	0
Business Information System	0	1
Information System Engineering	2	0
Chinese Studies	1	0

Research Location

This study was mainly targeting UTAR Kampar undergraduate students. According to UTAR Education Foundation (2019), there are more than 9,000 university students currently studying in the UTAR Kampar campus. Moreover, university students are generally feeling sad and exhausted due to the highly stressful context in tertiary education period (Al-Naggar & Al-Naggar, 2012). Thus, the psychology laboratory in UTAR Kampar campus was applied as the experiment setting for this study. The room temperature of the psychology laboratory was set at 25ºC as it was preset by the central control system of the UTAR Kampar campus.

Research Instruments

Demographic Questionnaire. A demographic questionnaire was utilized to collect participants' information on age, gender, ethnicity, year of study, type of faculty, type of course studied, and health status.

Positive and Negative Affect Schedule (PANAS). The PANAS (Watson, Clark, & Tellegen, 1988) was utilized to determine the participants' affection before and after the intervention. It is a self-administered questionnaire designed to evaluate an individual's positive and negative state of emotions. It consists of two subscales, which are Positive Affect (PA) and Negative Affect (NA). There are 20 items in PANAS totally with 10 items for each subscale respectively. PA assesses the extent to which an individual feels pleasure, conscientiousness and energetic (Watson et al., 1988). The 10 items of PA are 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Examples of items are "Interested" and "Excited". In contrast, NA assesses the extent to which an individual feels anxious, displeasure and disgust (Watson et al., 1988). The 10 items of NA

are 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Examples of items are “Distressed” and “Upset”. The scoring is based on a five-point Likert scale, ranging from 1 (Very slightly or not at all) to 5 (Extremely) for both PA and NA. The total score is obtained by computing the score of all items of PA and NA respectively. The total score is ranged from 10 to 50 for each subscale. For PA, higher scores imply higher levels of PA. For NA, lower scores imply lower levels of NA.

The PANAS had a high internal consistency for both PA with an alpha coefficient ranging from 0.86 to 0.90 and NA with an alpha coefficient ranging from 0.84 to 0.87 (Watson et al., 1988). The test-retest reliability of the PANAS was high with an alpha coefficient of 0.79 for PA and 0.81 for NA (Watson et al., 1988). For construct validity, both subscales, PA and NA, were found to be high with a non-clinical general adult population (Crawford & Henry, 2004).

The reliability of PANAS in this study was accomplished. The PANAS had an internal consistency with an alpha coefficient of 0.901 for PA and 0.875 for NA before the intervention. After the intervention, the PANAS had an internal consistency with an alpha coefficient of 0.925 for PA and 0.892 for NA.

State-Trait Anxiety Inventory (STAI). The STAI (Spielberger et al. as cited in Van Blyderveen et al., 2016)was employed to evaluate the participants’ anxiety states before and after the intervention. It is a self-administered questionnaire that encompasses two subscales, which are the State Anxiety Scale (S-anxiety) and the Trait Anxiety Scale (T-anxiety). There are 40 items in total in the STAI with 20 items each. The STAI S-Anxiety scale assesses the feelings that an individual experiences “right now, at the current moment” (Spielberger et al. as cited in Van Blyderveen et al., 2016). The items are ranging from item 1 to item 20 in the STAI. Examples of these items are “I feel secure” and “I feel strained”. Besides, the STAI T-Anxiety scale examines the feelings in which an individual experiences “generally” (Spielberger et al. as

cited in Van Blyderveen et al., 2016). The items are ranging from item 21 to item 40 in the STAI. Examples of these items are “I feel pleasant” and “I am content”. Additionally, both STAI S-Anxiety and STAI T-Anxiety scales also comprise two factors, including anxiety-present and anxiety-absent. The anxiety-absent items are item 1, 2, 5, 8, 10, 11, 15, 16, 19, and 20 in the STAI S-Anxiety scale whereas item 21, 23, 26, 27, 30, 33, 34, 36, and 39 in STAI T-Anxiety scale. The scorings of both STAI S-Anxiety and STAI T-Anxiety scales are based on a four-point Likert Scale, ranging from 1 (Not at all) to 4 (Very much so) and ranging from 1 (Almost Never) to 4 (Almost Always) respectively. The total score of each subscale is achieved by firstly reversing the scores of anxiety-absent items and secondly computing the scores of 20 items respectively. The total scores of both subscales also range from 20 to 80. The higher scores represent a higher level of anxiety.

The STAI S-Anxiety scale was found to have a high reliability with an alpha coefficient ranging from 0.83 to 0.92 (Spielberger et al. as cited in Barnes, Harp, & Jung, 2002). However, the test-retest reliability of the STAI S-Anxiety scale was relatively low, with an alpha coefficient ranging from 0.16 to 0.62. Its low-reliability coefficient may due to the effect of certain situational factors that exist during the moment of taking a test (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The construct validity of the STAI S-Anxiety scale was found to be higher with the college students who were under a stressful situation as compared to other students who were under relaxation situation (Spielberger et al., 1983).

The STAI T-Anxiety scale was found to have a high reliability with an alpha coefficient ranging from 0.86 to 0.92 (Spielberger et al. as cited in Barnes, Harp, & Jung, 2002). The test-retest reliability of the STAI T-Anxiety scale was high with an alpha coefficient ranging from 0.73 to 0.86 (Spielberger et al., 1983). The construct validity of the STAI T-Anxiety scale was

found to be higher with the psychiatric patients who obtained a higher score as compared to normal patients (Spielberger et al., 1983).

The reliability of STAI in this study was accomplished. The STAI had an internal consistency with an alpha coefficient of 0.876 for the STAI S-Anxiety scale and 0.889 for the STAI T-Anxiety scale before the intervention. After the intervention, the STAI had an internal consistency with an alpha coefficient of 0.918 for the STAI S-Anxiety scale and 0.916 for the STAI T-Anxiety scale.

Villa Serena. Villa Serena (Wild Divine, n.d.) with the second Generation was employed as an intervention in this study. It is a biofeedback game that assists individuals to achieve a natural state of balance by practicing their breathing technique while playing the game. Participants were considered as achieving a state of balance when they experience more positive emotions, increase their concentration, clear their mind, and completely relax from stressful situations.

In the beginning, participants were brought into Villa Serena that had been destroyed and given a task to repair and restore it to its former prestige. To accomplish this task, the participants were required to stay still, let go, and breathe deeply, slowly as well as regularly.

When participants were breathing while completing their repair task, their HR signals were taken by Wild Divine IOM active feedback hardware and were analyzed to illustrate that how the participants' breathing cycle could be practiced to become deeper, slower and more regular. Furthermore, if the participants were concentrating enough while repairing Villa Serena, they were able to breathe in time to a breathe visual cue (a blue butterfly). This assisted their HRs to fall into a resonant frequency which was known as Coherence. At this strongest and most stabilizing state, there were many positive changes happened in the body and helped participants clear their mind to achieve a natural state of balance.

There were totally five difficulty levels offered in Villa Serena, which were “Very Easy” (40% Coherence), “Easy” (60% Coherence), “Normal” (70% Coherence), “Difficult” (85% Coherence), and “Very Difficult” (95% Coherence). The higher the difficulty level, the more breath cycles were needed to complete the task. “Normal” level was suggested in this study. Thus, the participants were required to achieve 70% Coherence to restore Villa Serena successfully (Wild Divine, n.d.). Besides, the breathing cycle was offered in a range from 8 to 14 seconds in Villa Serena. The breathing cycle with 8 seconds was set according to the specific needs of participants in this study.

The “Visual Breathing Cue” referred to a blue butterfly. Its wings opened and closed repeatedly to guide the participants about breathing pattern. This breathing pattern affected their HR variability and coherence scores in repairing Villa Serena. The participants needed to inhale when the butterfly’s wings opened and exhale when the wings closed. Also, they were instructed to adjust their breathing gently to avoid feeling uncomfortable or unnatural while playing the game. They had to let their bellies expanded and contracted gently when they inhaled and exhaled respectively. This was because “trying harder” would not help participants meet relaxation goals effectively.

Plate 3.1 Outside of Villa Serena.

Plate 3.2 Inside of Villa Serena.

Microsoft Minesweeper. Microsoft Minesweeper (Kaye, 2000) is a classic puzzle game of Microsoft Windows. It was employed as the game for the control group in this study. The participants were shown an initially all blank grid in the game. There might be a number, flag or bomb hiding under each grid. Participants selected each grid randomly or according to the number given throughout the game. They won the game if they never clicked on the bomb until the end of the game. They lost if they clicked on the bomb, then they had to replay it.

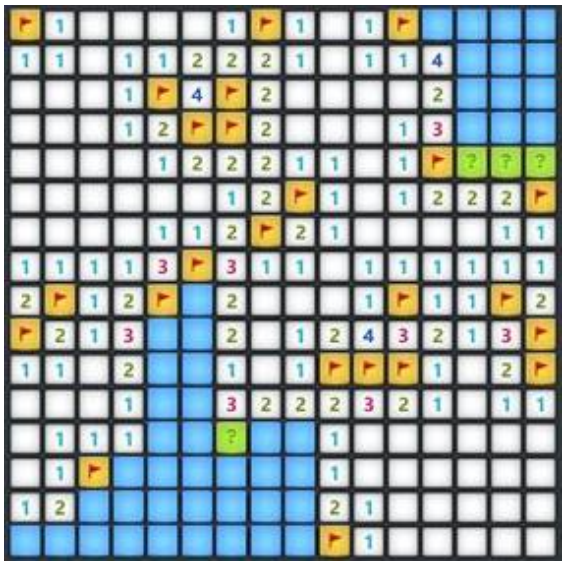

Plate 3.3 Microsoft Minesweeper.

Wild Divine IOM Hardware. Wild Divine IOM active feedback hardware is a lightweight hardware device that is used to measure an individual's HR (Schuller, Friedmann, & Eyben, 2013). It was connected to the computer with Windows 10 Pro by using a USB. Concurrently, it was paired with the pulse finger sensor that was connected to participants' fingertips to detect their pulse rates while they were playing Villa Serena or Microsoft Minesweeper. Participants' HRs were shown in the Wild Divine IOM Grapher that expressed as beats per minute (bpm). The HRV, which is the variation in the beat-to-beat interval, was calculated.

Plate 3.4. Wild Divine IOM Hardware.

Research Procedures

Consent. A consent form was given to the participants as they got into the laboratory. They were informed about risk and discomfort as well as the benefits of participating in this study. Voluntary participation and available medical treatment in this study were explained too. Additionally, participants were informed that they would be blinded throughout this study. They were required to read through an "Instructions" paper to get the instructions of what they should do in this study. Ten minutes were given to the participants for reading through the consent form and leaving a sign if they agreed to proceed and actively participate in this study.

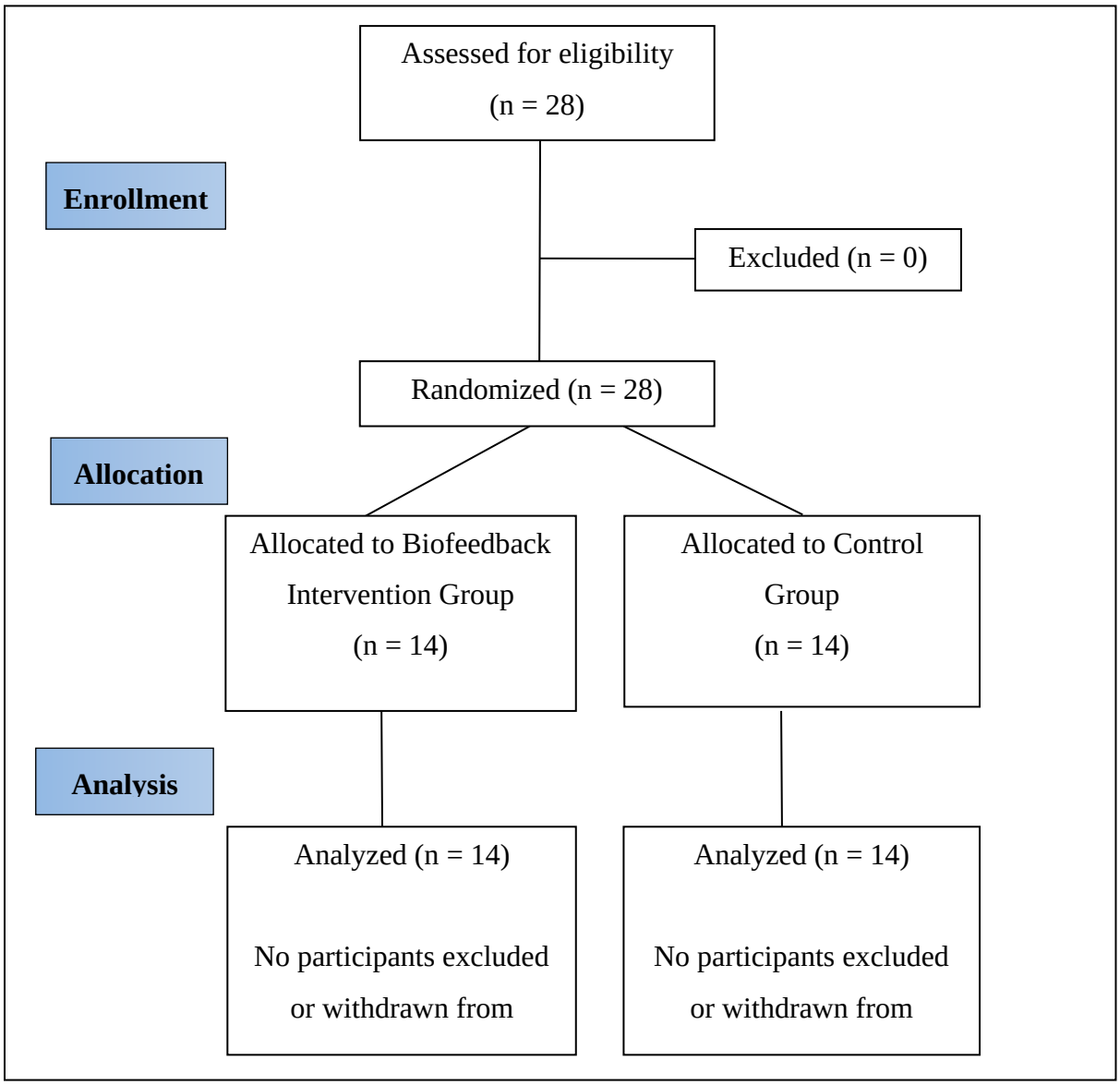

Figure 3.1 The CONSORT flowchart illustrated the randomized controlled trial (RCT) in this study.

Pre-test measurement. Before proceeding to the intervention, participants were requested to fill in a self-administered questionnaire which consisted of the demographic questionnaire, the PANAS, and the STAI (STAI S-Anxiety scale and STAI T-Anxiety scale). They were given 15 minutes to complete the questionnaire. Then, participants were randomly assigned to either intervention or control group by using an online random sequence generator.

Participants who got an even number were assigned into the intervention group while those who got an odd number were assigned into the control group.

Biofeedback intervention group. Participants in intervention group were instructed to play a biofeedback game named Villa Serena. Before starting playing game, pulse finger sensor was connected to the participants' fingers to detect their pulse rate. IOM sensor signal on Villa Serena should be showing Green/Good to ensure that the sensor was connected and functioning well. Then, participants were given 45 minutes to play Villa Serena. Their HRs, while they were playing Villa Serena, were recorded in Wild Divine IOM Grapher. Their HRs' records were saved as a photo and PDF file individually for result analysis purpose.

Control group. Participants in control group were directed to play Microsoft Minesweeper game. Medium mode was selected for this study. Before playing the game, pulse finger sensor was connected to the participants' fingers to detect their pulse rate. Participants were offered 45 minutes to play Microsoft Minesweeper. Their HRs, while playing Microsoft Minesweeper, were recorded in Wild Divine IOM Grapher. Their HRs' records were saved as a photo and PDF file individually for result analysis purpose.

Post-test measurement. After the intervention, participants were requested to fill in a self-administered questionnaire which contained the PANAS and the STAI (STAI S-Anxiety scale and STAI T-Anxiety scale). They were given 15 minutes to complete it. Then, participants were debriefed about this study's objective. They were also promised that their private information and HRs would be kept confidential and would not be exposed to the third party. Moreover, participants were requested to keep a promise of what they had known about this study to avoid the exposure of this study's details to other students.

Data Analysis

The demographic, the PANAS and the STAI data were collected by adopting pen-and-paper surveys. HRs were collected by Wild Divine IOM Hardware, and HRV data were calculated and obtained from Wild Divine IOM Grapher. All data were analyzed using JASP 0.11.1 software. Analysis of covariance (ANCOVA) was employed to analyze the data of pre-test and post-test for both intervention and control group. ANCOVA is a mixture of analysis of variance (ANOVA) and regression which is used to examine the differences between the means of dependent variables in multiple groups while taking into consideration the effects of covariates on dependent variables (Sampson, 2018).

The normality test was accomplished by performing a Q-Q plot to examine if the dataset were well-modelled by a normal distribution (Sampson, 2018). Q-Q plot illustrates the quantiles of data in a distribution plot instead of a normal distribution graph. If all the points are close to the reference line, the Q-Q plot shows that the data are normally distributed. However, if the points are "sag" or snake around the reference line, the data are not normally distributed (Sampson, 2018).

Homogeneity of variance test was accomplished by performing Levene's test to examine if the variances were equal across different groups (Sampson, 2018). The result of Levene's test is presented as a *p*-value. If the *p*-value is not significant ($p>.05$), the test shows that the variances across different groups are equal. However, if the *p*-value is significant ($p<.05$), the variances across different groups are unequal (Sampson, 2018).

Chapter IV

Findings and Analysis

Adjustment of Outliers

No outlier being adjusted as there was no significant outlier being identified in this study.

Normality of Data

The distributions of the points of PA, NA, STAI S-Anxiety, STAI T-Anxiety and HRV data in both intervention and control group were close to the reference lines in Q-Q plots (see Appendix I). The results showed that the data of PA, NA, STAI S-Anxiety, STAI T-Anxiety and HRV in both intervention and control group were normally distributed.

Homogeneity of Variance

From table 4.1, all the *p*-values in Levene's tests are not significant ($p>.05$), showing that the variances of all data across intervention and control group are equal.

Table 4.1

The p-value of Data in Both Intervention and Control Group

	p-value
PA	.522
NA	.202
STAI S-Anxiety	.515
STAI T-Anxiety	.329
HRV	.186

Analysis of Covariance (ANCOVA)

Positive Affect (PA). ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-PA controlling for Pre-PA. The covariate, Pre-PA, was not significantly related to the Post-PA, $F(1,25) = 3.329$, $p=.080$, $\omega^2 = 0.078$. There was also no significant effect of biofeedback game on Post-PA after controlling for Pre-PA, $F(1, 25) = 0.432$, $p=.517$, $\omega^2 = 0.000$.

Table 4.2

ANCOVA for the Difference between Games on Post-PA Controlling for Pre-PA

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	35.618	1.000	35.618	0.432	0.517	0.000
Pre-PA	274.786	1.000	274.786	3.329	0.080	0.078
Residual	2063.286	25.000	82.531			

Note. Type III Sum of Squares

Negative Affect (NA). ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-NA controlling for Pre-NA. The covariate, Pre-NA, was significantly related to the Post-NA, $F(1,25) = 20.619$, $p<.001$, $\omega^2 = 0.420$. There was no significant effect of biofeedback game on Post-NA after controlling for Pre-NA, $F(1, 25) = 0.139$, $p=.713$, $\omega^2 = 0.000$.

Table 4.3

ANCOVA for the Difference between Games on Post-NA Controlling for Pre-NA

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	3.921	1.000	3.921	0.139	0.713	0.000
Pre-NA	583.601	1.000	583.601	20.619	< .001	0.420
Residual	707.613	25.000	28.305			

Note. Type III Sum of Squares

State-Trait Anxiety Inventory (STAI) State Anxiety (S-Anxiety). ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-STAI S-Anxiety controlling for Pre-STAI S-Anxiety. The covariate, Pre-STAI S-Anxiety, was not significantly related to the Post-STAI S-Anxiety, $F(1,25) = 12.630$, $p=.002$, $\omega^2 = 0.301$. There was no significant effect of biofeedback game on Post-STAI S-Anxiety after controlling for Pre-STAI S-Anxiety, $F(1, 25) = 0.016$, $p=.900$, $\omega^2 = 0.000$.

Table 4.4

ANCOVA for the Difference between Games on Post-STAI S-Anxiety Controlling for Pre-STAI S-Anxiety

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	1.470	1.000	1.470	0.016	0.900	0.000
Pre-STAI S-Anxiety	1150.447	1.000	1150.447	12.630	0.002	0.301
Residual	2277.124	25.000	91.085			

Note. Type III Sum of Squares

State-Trait Anxiety Inventory (STAI) Trait Anxiety (T-Anxiety). ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle

game on Post-STAI T-Anxiety controlling for Pre-STAI T-Anxiety. The covariate, Pre-STAI T-Anxiety, was significantly related to the Post-STAI T-Anxiety, $F(1,25) = 67.972$, $p<.001$, $\omega^2 = 0.697$. There was no significant effect of biofeedback game on Post-STAI T-Anxiety after controlling for Pre-STAI T-Anxiety, $F(1, 25) = 2.115$, $p=.158$, $\omega^2 = 0.012$.

Table 4.5

ANCOVA for the Difference between Games on Post-STAI T-Anxiety Controlling for Pre-STAI T-Anxiety

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	88.066	1.000	88.066	2.115	0.158	0.012
Pre-STAI T-Anxiety	2829.985	1.000	2829.985	67.972	< .001	0.697
Residual	1040.872	25.000	41.635			

Note. Type III Sum of Squares

Heart Rate Variability (HRV). ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-HRV controlling for Pre-HRV. There was a significant effect of biofeedback game on Post-HRV after controlling for Pre-HRV, $F(1, 26) = 88.665$, $p<.001$, $\omega^2 = 0.758$. The effect size was large.

Table 4.6

ANCOVA for the Difference between Games on Post-HRV Controlling for Pre-HRV

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	3521.286	1.000	3521.286	88.665	< .001	0.758
Residual	1032.571	26.000	39.714			

Note. Type III Sum of Squares

Chapter V

Discussion

Discussion and Implication of Study

Previous studies noted Biofeedback game improved emotional regulation and reduce anxiety by training the respiration rate into a relaxation state (Fagundo et al., 2013; Knox et al., 2011; Schoneveld et al., 2016), it was hypothesized that participants will show that the biofeedback game, Villa Serena, will have significant effects on PA, NA, STAI S-Anxiety, STAI T-Anxiety scores and HRV. However, the our results showed that the difference between the Villa Serena intervention group and the Minesweeper active control group for PA, NA, STAI S-Anxiety and STAI T-Anxiety results were not statistically significant, while the only statistically significant result between the Villa Serena intervention group and the Minesweeper active control group are the HRV.

Positive Affection and Negative Affection. The PA and HRV are not necessarily showing the significant interaction between HRV coherence and PA (Kim et al., 2018; Kotozaki et al., 2014). A study with 20 sessions shows that breathing technique can have no between-group difference effect on the PA, and concluded that the time point for the significant reduction of NA occurs is unknown (Ma et al., 2017). This result may be explained by the fact that a significant reduction of NA does not immediately occur for the first session. This is further supported by a one-session breathing technique training that produces a similar result for NA, which intervention group has no significant difference with the sham group (Johnson, Gur, David, & Currier, 2013). A note of caution is due here since there is statistical significance for both pre and post group in NA, the effectiveness of Villa Serena on reducing the NA remains

unconcluded. Hence, this combination of findings provides some support for the conceptual premise that the reduction of NA may need multiple sessions to occur as significant.

Anxiety. A study on the effectiveness of respiratory-sinus-arrhythmia biofeedback on state-anxiety, showed that it's possible to show a result that is statistically significantly decreased in both intervention and control groups (Mikosch et al., 2010). This is presumably correlated with stress reduction and/or emotional relief after the experiment had been completed. In a similar Biofeedback training that further tracks the physiological symptoms, it has shown a comparable result that anxiety score has no significant difference from no-intervention control after the intervention (Kotozaki et al., 2014). This observation may support the hypothesis that the reduction of anxiety may need long period training to be significant. As supported by the detailed table from research that shows signs of the game treatment starts to take effect on treating anxiety from the third session (Schoneveld et al., 2016). However, with small sample size, caution must be applied, as the findings might not be able to apply to the general public and general biofeedback game treatment. This finding has important implications for developing future biofeedback game treatment studies on anxiety. Hence, further studies, which take these variables into account, will need to be undertaken.

Heart Rate Variability. A strong relationship between HRV and Biofeedback game has been reported in the literature. The current study found that as a game that aims to train the breathing technique and leading to HRV coherence, Villa Serena is performing significantly better than the Minesweeper control group. These results are in line with those of previous studies (Fagundo et al., 2013; Kim et al., 2018; Sutarto, Wahab, & Zin, 2010). The present study raises the possibility that biofeedback game, Villa Serena, can be useful as a tool to enhance the stable physiological symptoms in terms of HRV coherence.

Limitation and Recommendation

This study was faced with some limitations and must be acknowledged. Firstly, the participants may lose their attention towards the game in such a long gameplay session. It may influence the gaming experience of participants and the result of the study. Secondly, the time limit for every gameplay session is not standardized for every participant, which is 5 minutes at most less than expected. An unstandardized time limit means that the 45-minutes gameplay session is incomplete and not meeting the target. The IOM finger Grapher fails to detect the pulse consistently due to unknown reason, thus causing unstandardized time measurement to occur in the result. Thirdly, the sample size for this study is small which can limit the significance of the result. The purposive sampling method is used as the samples are only recruited in UTAR, one specific university in the northern peninsula of Malaysia, which limits the effect of generalization to the population (Knapp, 2016).

Throughout this study, there are some recommendations suggested for those who are interested in this topic. Firstly, a 45-minutes gaming session was conducted for each participant to collect their HRV data. Therefore, there is a need to reduce the duration of sessions in order to maintain participants' attention. Secondly, there is a need for using another biofeedback device for replacing the originally used biofeedback device (Wilson, 2009). For instance, an ear-clip IOM device developed by Unyte Health Inc. (formerly known as Wild Divine). It can also measure the HRV and it is simple to use. Thirdly, a probability sampling method can be adopted instead to repeat this study. It can decrease the sampling bias when recruiting participants from different states in Malaysia. Thus, it can include diversified potential participants to improve the accuracy and generalizability of the result to the target population (Knapp, 2016).

Conclusion

In summary, this study aimed to investigate the effects of biofeedback game on affection and anxiety among undergraduates. This study provides some insights regarding the biofeedback game and its effect on affection and anxiety in undergraduate students. The findings indicate that biofeedback game has a significant effect on HRV. All of the variables have significant differences between pre and post-test, except for PA. This study provides a great direction for future researchers to establish the full potential of biofeedback games as a kick-starter affective game for the target population.

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Appendix A

Informed Consent Form

UNIVERSITI TUNKU ABDUL RAHMAN (UTAR)
FACULTY OF ART AND SOCIAL SCIENCE (FAS)
DEPARTMENT OF PSYCHOLOGY AND COUNSELLING

PARTICIPANT INFORMATION SHEET

Biofeedback Game, Affects and Anxiety
You are invited to participate in a research experimental study. Before you decide whether or not to participate, it is significant to let you know why the research is being conducted and what it involves. Please take time to read through the following information carefully and decide whether or not you would like to participate in this research study. Please do not hesitate to ask questions if there is anything that is not clear or if you would like to know more information.

Purpose of Study
This research study is conducted to fulfil the requirements of our Final Year Project (FYP). In order to collect the required information, your participation in this research study is highly appreciated.

Who is Associated with The Research Study?
This research study is jointly conducted by Ling Gong Shuen, Ng Kuan Sien and Tan Pei Chin from Universiti Tunku Abdul Rahman (UTAR).

Who is Eligible to This Research Study?
Undergraduate students, who aged from 18 to 24 years old, from UTAR Kampar campus, and without cardiovascular disease, are eligible to participate in this study.

Procedures
You will be requested to complete a computerized task that requires you to play a computer game. Moreover, you also have to fill in questionnaires that include your demographic, positive and negative emotion as well as feeling and experience towards anxiety. You will be blinded in this research study, thus you have to read through notepad to get full instructions on how to complete the tasks. The entire study will be taking about 1 hour and 30 minutes.

Risk and Discomfort

We are requesting you to share with us information that may be personal and confidential, and you might feel uncomfortable about some topics. You may decide to terminate and withdraw from this research study as you will not be held any responsibility for opting out. If you face any issue such as distress or not feeling well after your participation in this research study, please do not hesitate to contact us or UTAR Counselling and Guidance Unit for counselling service at Block C.

Benefit
There will be no direct benefit for you, but your participation is likely to assist us in collecting data for our research study.

Voluntary Participation
Your participation in this research study is totally voluntary. If you decide to participate, you will be given this information sheet to keep and will be requested to leave a sign on a consent form. You have the right to withdraw from the research study halfway without any reason, there will be no penalty or loss of benefits to you.

Available Medical Treatment
If you are injured during your participation in this research study, or your injury is whether or not a direct result of this research study, UTAR will not be liable for any loss, damage or compensation of medical treatment. However, assistance will be offered to you in getting emergency medical treatment if you need it.

Confidentiality
All the information you have given in this research study will be kept confidential and will not be made available to the public unless disclosure is required by law. All of the data of this research study will neither be exposed to the third party nor be used for any other purpose excluding this research study.

Contact Person
Thank you for your interest in our research study. If you have any inquiry regarding this research study, please do not hesitate to contact us through:

Ling Gong Shuen	wilsonling926@gmail.com
Ng Kuan Sien	zims2035@gmail.com
Tan Pei Chin	carolsnow131@gmail.com
Pheh Kai Shuen (Supervisor)	phehks@utar.edu.my

Statement of Consent
I have read through the information above. I have asked any question I have about this research study and they have answered me well. I agree to participate in this research study.

Signature of Participant:_____ Date:_____

Appendix B

Participants' Demographic Information

Age: _____

Gender: Male / Female

Ethnicity: Chinese / Malay / Indian

Year of Study: _____

Type of Faculty: _____

Type of Course Studied: _____

Cardiovascular Disease: Yes / No

Appendix C

The Positive and Negative Affect Schedule (PANAS)

Instructions: This scale consists of a number of words that describe different feelings and emotions. Read each item and then circle the number that indicates how you feel ***right now***, that is, ***at this moment***. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

Indicate the extent you have felt at this moment		Very Slightly or Not at All	A Little	Moderately	Quite A Bit	Extremely
1.	**Interested**	1	2	3	4	5
2.	**Distressed**	1	2	3	4	5
3.	**Excited**	1	2	3	4	5
4.	**Upset**	1	2	3	4	5
5.	**Strong**	1	2	3	4	5
6.	**Guilty**	1	2	3	4	5
7.	**Scared**	1	2	3	4	5
8.	**Hostile**	1	2	3	4	5
9.	**Enthusiastic**	1	2	3	4	5
10.	**Proud**	1	2	3	4	5
11.	**Irritable**	1	2	3	4	5
12.	**Alert**	1	2	3	4	5
13.	**Ashamed**	1	2	3	4	5
14.	**Inspired**	1	2	3	4	5
15.	**Nervous**	1	2	3	4	5
16.	**Determined**	1	2	3	4	5
17.	**Attentive**	1	2	3	4	5
18.	**Jittery**	1	2	3	4	5
19.	**Active**	1	2	3	4	5
20.	**Afraid**	1	2	3	4	5

Appendix D

State-Trait Anxiety Inventory (STAI) S-Anxiety Scale

Instructions: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the number that indicates how you feel ***right now***, that is, ***at this moment***. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

Indicate the extent you have felt at this moment	Not at All	Somewhat	Moderately So	Very Much So
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I feel jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

Appendix E

State-Trait Anxiety Inventory (STAI) T-Anxiety Scale

Instructions: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the number that indicates how you ***generally*** feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your general feelings best.

Indicate the extent you have generally felt	**Not at All**	**Somewhat**	**Moderately So**	**Very Much So**
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decision easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

Appendix F

Online Random Sequence Generator

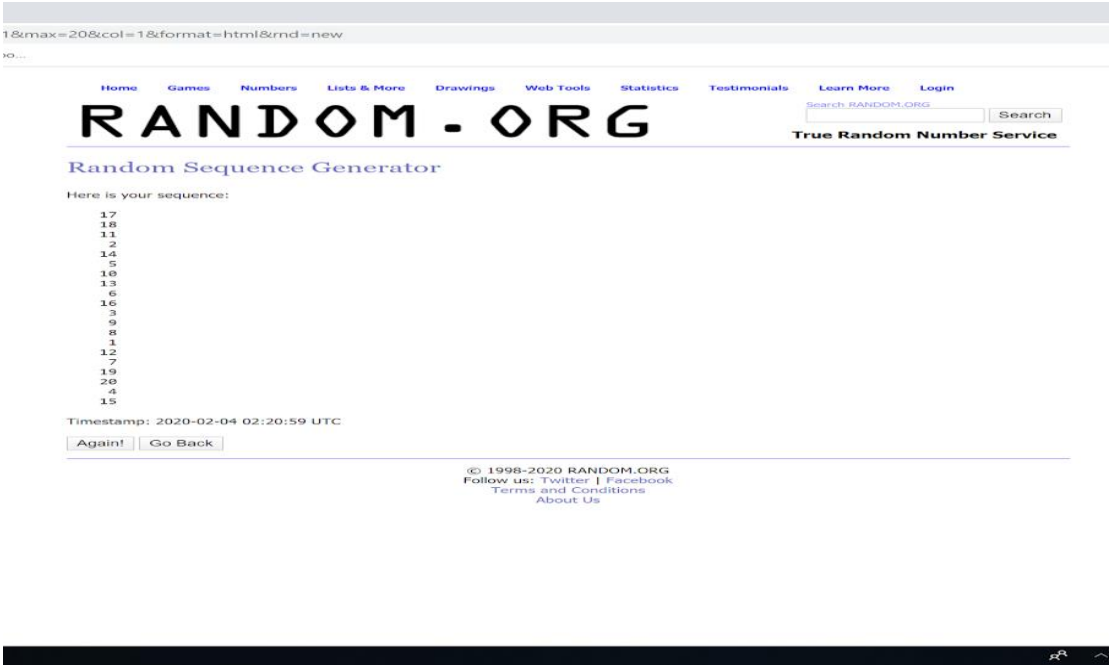

Figure 6.1 Online Random Sequence Generator List 1

Figure 6.2 Online Random Sequence Generator List 2

Appendix G

Instruction for Biofeedback Intervention Group

Hi, Welcome to Villa Serena!

Villa Serena has been destroyed and you are given a task to repair and restore it to its former prestige. To achieve this task successfully, you are required to stay still, let go, and breathe deeply, slowly as well as regularly.

Below are the instructions that you have to follow for playing Villa Serena later. Please read through these instructions before you start playing Villa Serena.

1. Please connect Wild Divine IOM Hardware (as shown in Plate 6.1) to your left hand's fingers (as shown in Plate 6.2).

Plate 6.1 Wild Divine IOM Hardware

Plate 6.2 Connection of Wild Divine IOM Hardware to fingers

2. Please ensure that IOM Signal, which is located at the lower left corner of Villa Serena's launch menu, shows Green/Good (as shown in Plate 6.3).

Plate 6.3 Launch Menu of Villa Serena

3. Then you have to set a timer for 45 minutes and start playing Villa Serena. However, you have to stop playing it when the time's up.

4. To start playing Villa Serena, you may click on the “PLAY” button as shown in Plate 3 above, and then, click on the “REPAIR” icon as shown in Plate 6.4 below.

Plate 6.4 The Front Door of Villa Serena

5. There will be a blue butterfly, which is a breathing cycle indicator, at the upper right corner (as shown in Plate 6.5). Its wings will open and close repeatedly. You have to inhale gently when the wings open and exhale gently when the wings close.

Plate 6.5 The Front Door of Villa Serena

6. You may also refer to Wild Divine IOM Grapher to view your heart rate and adjust your breathing cycle.

Appendix H

Instruction for Control Group

Hi, Welcome to Microsoft Minesweeper!

Microsoft Minesweeper is a puzzle game and you are given a task to play it for 45 minutes.

Below are the instructions that you have to follow for playing Microsoft Minesweeper later. Please read through these instructions before you start playing Microsoft Minesweeper.

1. Please connect Wild Divine IOM Hardware (as shown in Plate 6.6) to your left hand's fingers (as shown in Plate 6.7).

Plate 6.6 Wild Divine IOM Hardware

Plate 6.7 Connection of Wild Divine IOM Hardware to fingers

2. Then you have to set a timer for 45 minutes and start playing Microsoft Minesweeper. However, you have to stop playing it when the time's up.
3. As start playing Microsoft Minesweeper, you will be shown an initially all blank grid (as shown in Plate 6.8).

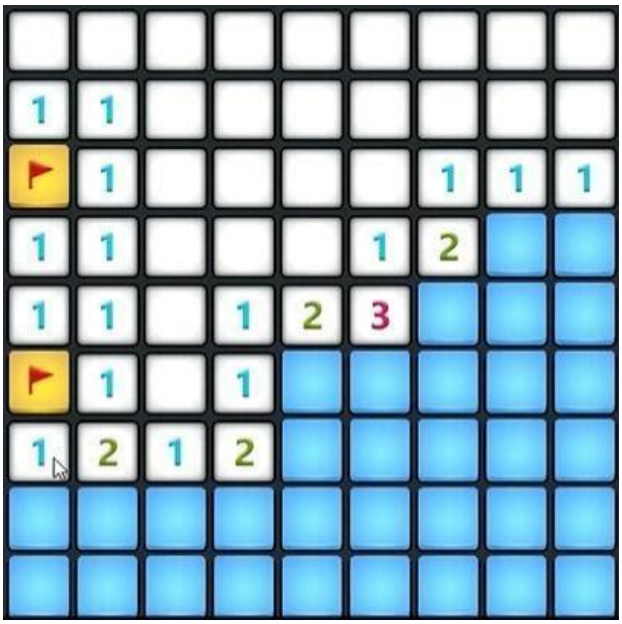

Plate 6.8 Microsoft Minesweeper

4. You may choose the grid randomly or according to the number shown.
5. No matters you win or lose it, you replay this game until the time's up.

Appendix I

Q-Q Plots of Each Variable

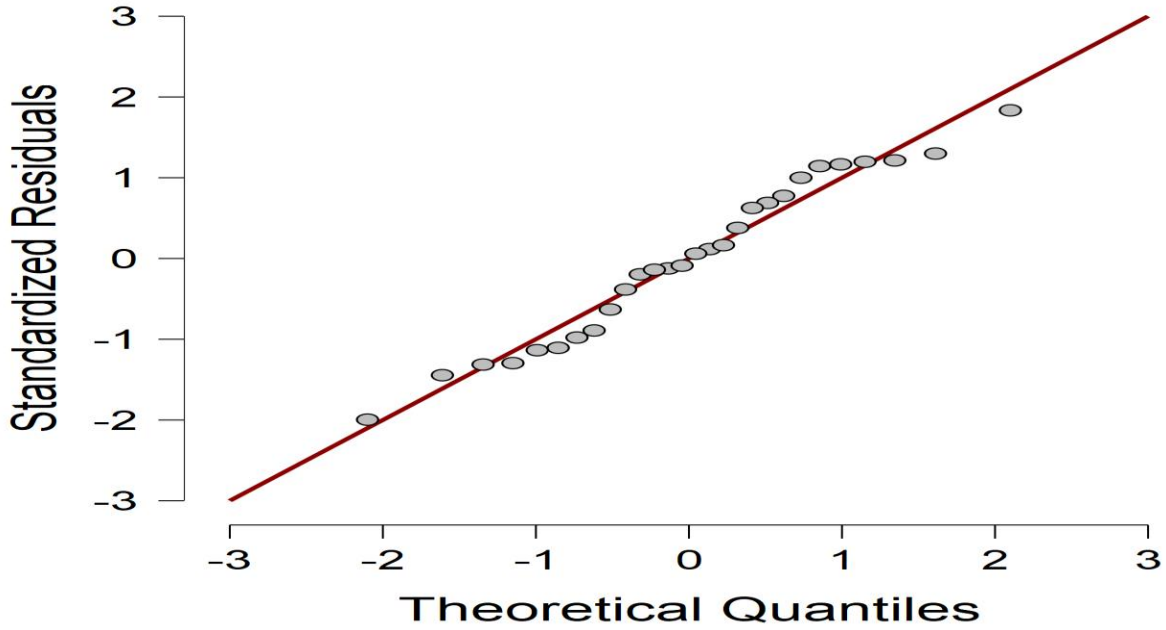

Figure 6.3 Q-Q Plot of PA

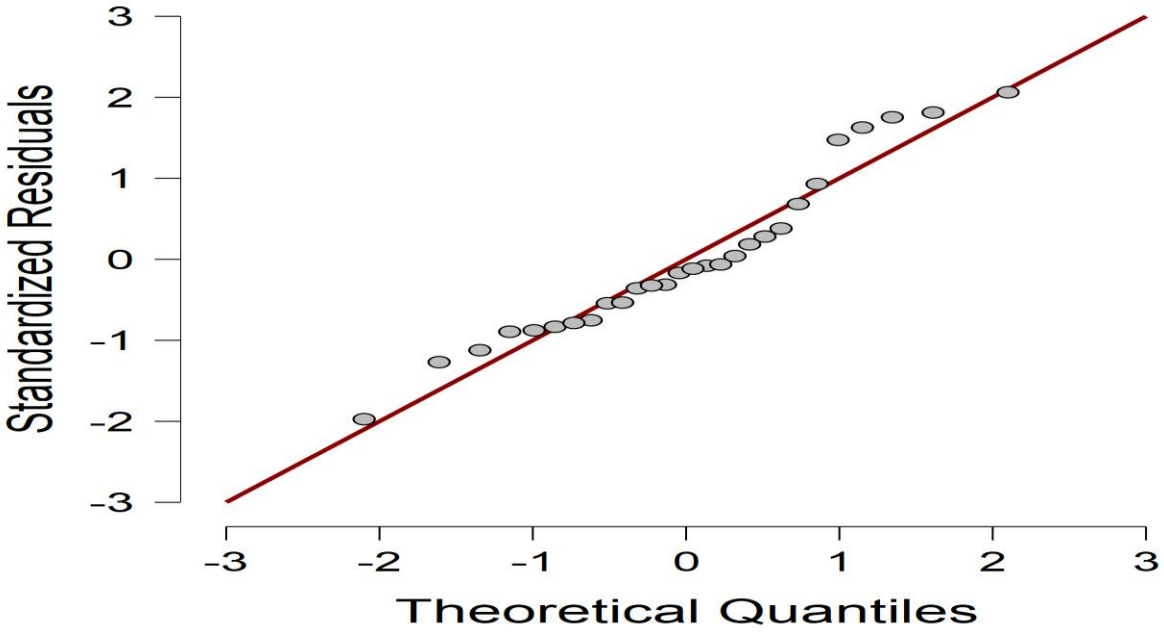

Figure 6.4 Q-Q Plot of NA

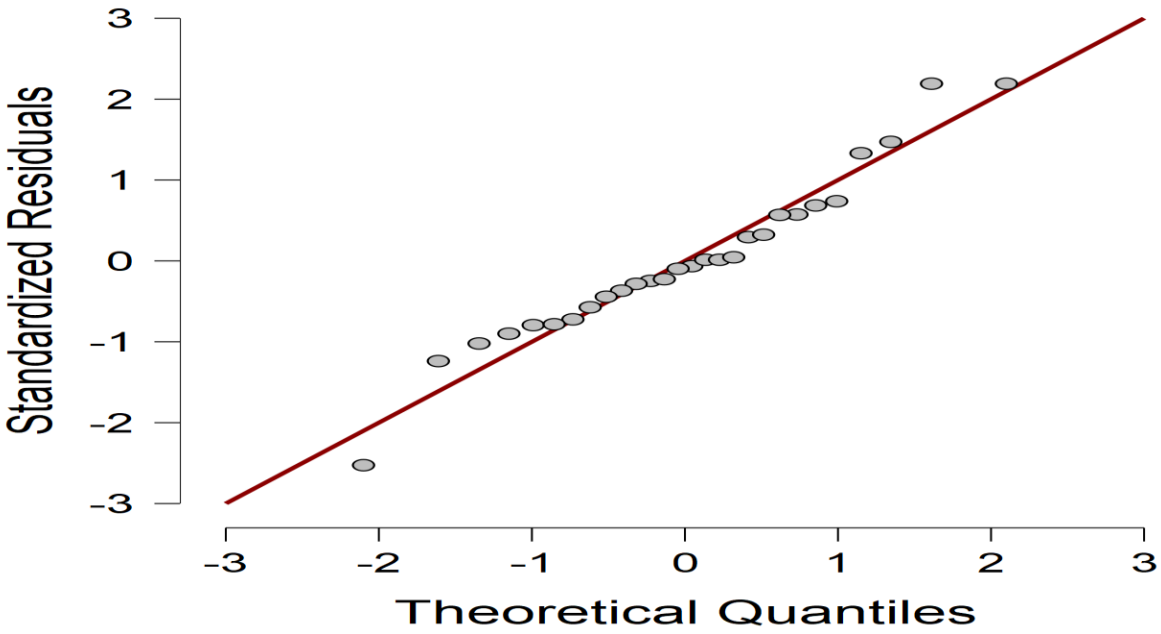

Figure 6.5 Q-Q Plot of STAI S-Anxiety

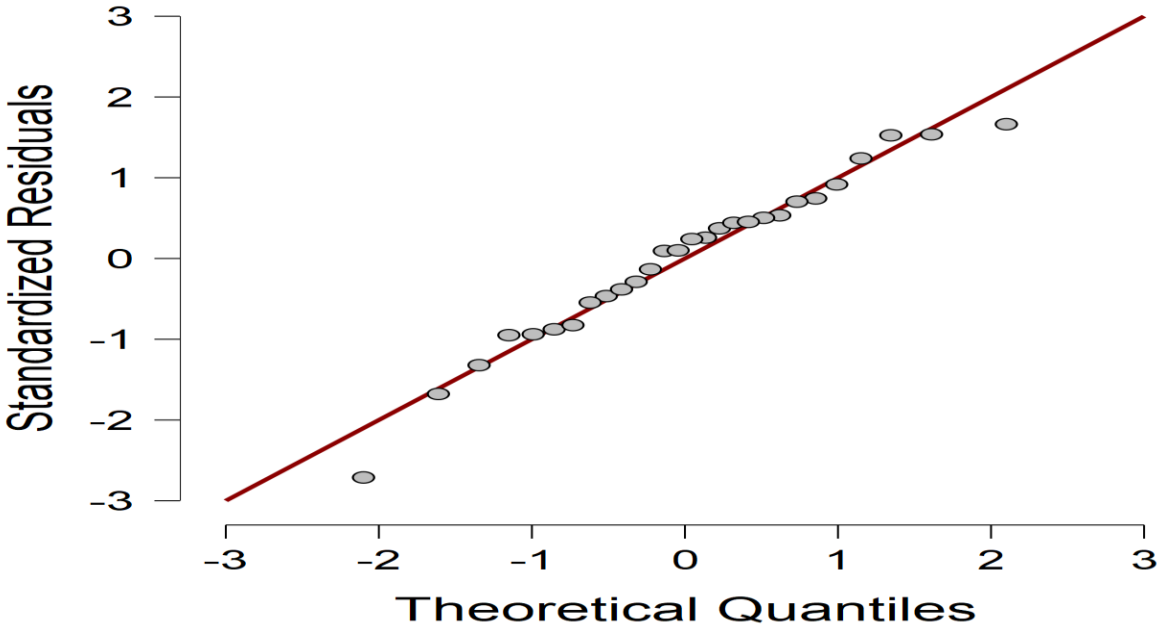

Figure 6.6 Q-Q Plot of STAI T-Anxiety

Appendix J

Sample Result of IOM Grapher on Coherence Score (Control Group and Intervention Group)

Plate 6.9 IOM Grapher on Coherence Score of Control Group

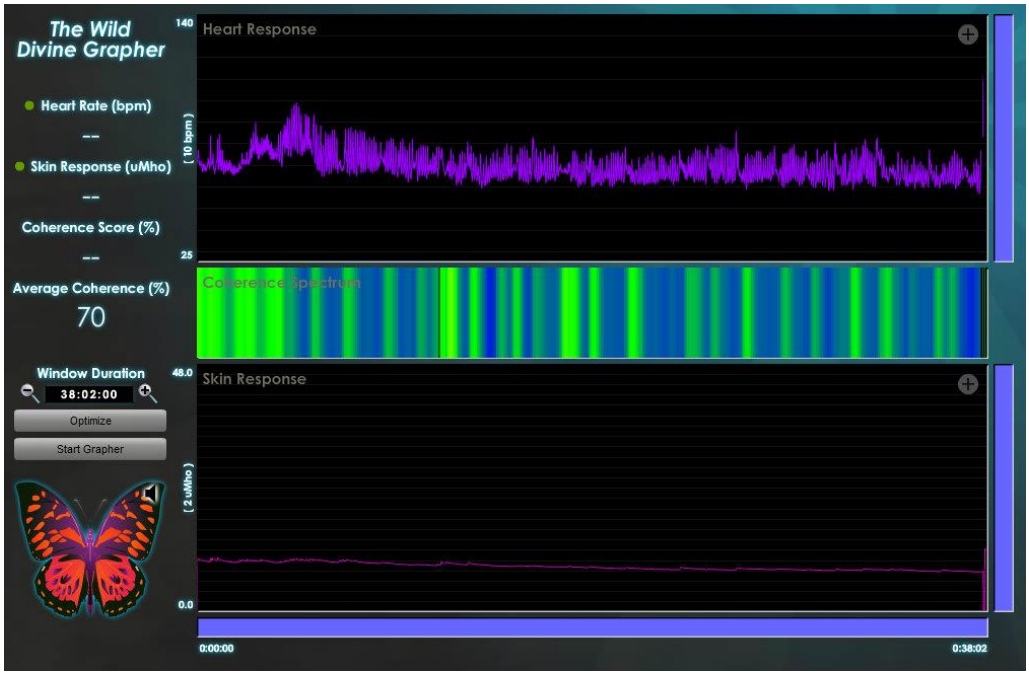

Plate 6.10 IOM Grapher on Coherence Score of Intervention Group

Appendix K

Turnitin report for FYP2

FYP 2

by Ng Kuan Sien

Abstract

This study aimed to investigate the effects of biofeedback game on affection and anxiety among undergraduate students. This study was conducted in an experimental study with pilot RCT design by using purposive sampling method. The participants are 28 undergraduate students in UTAR who aged from 18 to 22 years old with a mean age of 22 years old (SD = 1.14 for intervention group, SD = 1.33 for control group). The demographic questionnaire was given as serving for quantitative survey. Positive and Negative Affect Schedule (PANAS), State-Trait Anxiety Inventory (STAI) are used to measure the variables in this study. The result revealed that the heart rate variability has a statistically significant difference from the control group. All of the variables have significant differences between pre and post-test, except for positive affect. The limitation and recommendation of present study are discussed. In conclusion, the present study pointed out that biofeedback game and its effect towards physiological and psychological responses of undergraduate students' population.

Chapter 3

Methodology

Research Design

An experimental research design with pilot randomized controlled trial (RCT) design was employed in this study to determine the effects of a biofeedback game on undergraduate students' positive and negative affects as well as anxiety levels. This study was conducted as a pilot study to examine the feasibility of Villa Serena as an intervention for emotion regulation and anxiety reduction among undergraduate students. RCT design is a study in which the participants are randomly distributed into either intervention or control group (Akobeng, 2005; Kendall, 2003). This design was employed to compare the outcomes of this study to determine the effectiveness of intervention (Kendall, 2003) as well as eliminate selection bias and reduce the confounding factors to increase the accuracy of the study's results (Akobeng, 2005). Moreover, single-blind was applied in this study. Single-blind refers to a situation where participants are blocked from perceiving the details of the study they participate (Akobeng, 2005). The purpose was to avoid the participants from being affected by the knowledge of study which may lead to biased results (Akobeng, 2005).

Research Sample

The population for this research study involved all of the undergraduate students in the Universiti Tunku Abdul Rahman (UTAR) Kampar campus. Purposive sampling, which is a non-probability sampling method, was utilized to recruit the sample. Purposive

sampling is a way of selectively involving people with certain characteristics based on the study's aim to obtain desirable data to the study (Etikan, Musa, & Alkassim, 2016). The inclusion criteria were undergraduate students who ranged from 18 to 24 years old. The exclusion criteria were those students with cardiovascular disease.

According to Julious (2005), the rule of thumb suggested that a sample size of 12 is applicable for a pilot study. This sample size's justifications were depending on the rationale of feasibility, precision about mean and variance, and regulatory considerations (Julious, 2005). There were a total number of 28 undergraduate students recruited in this study. All participants were randomly and equally allocated into either the intervention or control group by using an online random sequence generator. Thus, both the intervention and control group involved 14 participants respectively. The intervention group comprised five males and nine females whereas the control group comprised three males and 11 females. Both intervention and control groups had the same average age of 22 years old. Table 3.1 below illustrates the demographic data of participants, including their genders, ethnicities, year of study, faculties and courses they are studying.

Table 1

The Demographic Data of The Participants in Intervention and Control Group

	Intervention Group	Control Group
Mean Age (SD)	22 (1.14)	22 (1.33)
Gender		
Male	5	3
Female	9	11
Ethnicity		
Chinese	14	14
Year of Study		
Year 1	2	2
Year 2	1	4
Year 3	9	7
Year 4	2	1
Faculty		
FAS	9	11
FBF	1	2
FEGT	1	0
FICT	2	1
ICS	1	0
Course		
Advertising	1	1
English Language	0	4

Guidance and Counselling	1	1
Journalism	0	1
Psychology	6	4
Public Relations	1	0
Banking and Finance	0	1
Entrepreneurship	1	0
Financial Economics	0	1
Construction Management	1	0
Business Information System	0	1
Information System	2	0
Engineering		
Chinese Studies	1	0

Research Location

This study was mainly targeting UTAR Kampar undergraduate students. According to UTAR Education Foundation (2019), there are more than 9,000 university students currently studying in the UTAR Kampar campus. Moreover, university students are generally feeling sad and exhausted due to the highly stressful context in tertiary education period (Al-Naggar & Al-Naggar, 2012). Thus, the psychology laboratory in the UTAR Kampar campus was applied as the experiment setting for this study. The room temperature of the psychology laboratory was set at 25°C as it was preset by the central control system of the UTAR Kampar campus.

Research Instruments

Demographic Questionnaire. A demographic questionnaire was utilized to collect participants' information on age, gender, ethnicity, year of study, type of faculty, type of course studied, and health status.

Positive and Negative Affect Schedule (PANAS). The PANAS (Watson, Clark, & Tellegen, 1988) was utilized to determine the participants' affection before and after the intervention. It is a self-administered questionnaire designed to evaluate an individual's positive and negative state of emotions. It consists of two subscales, which are Positive Affect (PA) and Negative Affect (NA). There are 20 items in PANAS totally with 10 items for each subscale respectively. PA assesses the extent to which an individual feels pleasure, conscientiousness and energetic (Watson et al., 1988). The 10 items of PA are 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Examples of items are "Interested" and "Excited". In contrast, NA assesses the extent to which an individual feels anxious, displeasure and disgust (Watson et al., 1988). The 10 items of NA are 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Examples of items are "Distressed" and "Upset". The scoring is based on a five-point Likert scale, ranging from 1 (Very slightly or not at all) to 5 (Extremely) for both PA and NA. The total score is obtained by computing the score of all items of PA and NA respectively. The total score is ranged from 10 to 50 for each subscale. For PA, higher scores imply higher levels of PA. For NA, lower scores imply lower levels of NA.

The PANAS had a high internal consistency for both PA with an alpha coefficient ranging from 0.86 to 0.90 and NA with an alpha coefficient ranging from 0.84 to 0.87 (Watson et al., 1988). The test-retest reliability of the PANAS was high with an alpha coefficient of 0.79 for PA and 0.81 for NA (Watson et al., 1988). For construct validity,

both subscales, PA and NA, were found to be high with a non-clinical general adult population (Crawford & Henry, 2004).

The reliability of PANAS in this study was accomplished. The PANAS had an internal consistency with an alpha coefficient of 0.901 for PA and 0.875 for NA before the intervention. After the intervention, the PANAS had an internal consistency with an alpha coefficient of 0.925 for PA and 0.892 for NA.

State-Trait Anxiety Inventory (STAI). The STAI (Spielberger et al. as cited in Van Blyderveen et al., 2016) was employed to evaluate the participants' anxiety states before and after the intervention. It is a self-administered questionnaire that encompasses two subscales, which are the State Anxiety Scale (S-anxiety) and the Trait Anxiety Scale (T-anxiety). There are 40 items in total in the STAI with 20 items each. The STAI S-Anxiety scale assesses the feelings that an individual experiences "right now, at the current moment" (Spielberger et al. as cited in Van Blyderveen et al., 2016). The items are ranging from item 1 to item 20 in the STAI. Examples of these items are "I feel secure" and "I feel strained". Besides, the STAI T-Anxiety scale examines the feelings in which an individual experiences "generally" (Spielberger et al. as cited in Van Blyderveen et al., 2016). The items are ranging from item 21 to item 40 in the STAI. Examples of these items are "I feel pleasant" and "I am content". Additionally, both STAI S-Anxiety and STAI T-Anxiety scales also comprise two factors, including anxiety-present and anxiety-absent. The anxiety-absent items are item 1, 2, 5, 8, 10, 11, 15, 16, 19, and 20 in the STAI S-Anxiety scale whereas item 21, 23, 26, 27, 30, 33, 34, 36, and 39 in STAI T-Anxiety scale. The scorings of both STAI S-Anxiety and STAI T-Anxiety scales are based on a four-point Likert Scale, ranging from 1 (Not at all) to 4

(Very much so) and ranging from 1 (Almost Never) to 4 (Almost Always) respectively. The total score of each subscale is achieved by firstly reversing the scores of anxiety-absent items and secondly computing the scores of 20 items. The total scores of both subscales also range from 20 to 80. The higher scores represent a higher level of anxiety.

The STAI S-Anxiety scale was found to have high reliability with an alpha coefficient ranging from 0.83 to 0.92 (Spielberger et al. as cited in Barnes, Harp, & Jung, 2002). However, the test-retest reliability of the STAI S-Anxiety scale was relatively low, with an alpha coefficient ranging from 0.16 to 0.62. The low-reliability coefficient of the STAI S-Anxiety scale may due to the effect of certain situational factors that exist during the moment of taking a test (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The construct validity of the STAI S-Anxiety scale was found to be higher with the college students who were under a stressful situation as compared to other students who were under relaxation situation (Spielberger et al., 1983).

The STAI T-Anxiety scale was found to have a high reliability with an alpha coefficient ranging from 0.86 to 0.92 (Spielberger et al. as cited in Barnes, Harp, & Jung, 2002). The test-retest reliability of the STAI T-Anxiety scale was high with an alpha coefficient ranging from 0.73 to 0.86 (Spielberger et al., 1983). The construct validity of the STAI T-Anxiety scale was found to be higher with the psychiatric patients who obtained a higher score as compared to normal patients (Spielberger et al., 1983).

The reliability of STAI in this study was accomplished. The STAI had an internal consistency with an alpha coefficient of 0.876 for the STAI S-Anxiety scale and 0.889 for the STAI T-Anxiety scale before the intervention. After the intervention, the STAI had an internal consistency with an alpha coefficient of 0.918 for the STAI S-Anxiety scale and

0.916 for the STAI T-Anxiety scale.

Villa Serena. Villa Serena (Wild Divine, n.d.) with the second Generation was employed as an intervention in this study. It is a biofeedback game that assists individuals to achieve a natural state of balance by practicing their breathing technique while playing the game. Participants were considered as achieving a state of balance when they experience more positive emotions, increase their concentration, clear their mind, and completely relax from stressful situations.

In the beginning, participants were brought into Villa Serena that had been destroyed and be given a task to repair and restore it to its former prestige. To accomplish this task, the participants were required to stay still, let go, and breath deeply, slowly as well as regularly.

When participants were breathing while completing their repair task, their HR signals were taken by Wild Devine Iom active feedback hardware and were analyzed to illustrate that how the participants' breathing cycle could be practiced to become deeper, slower and more regular. Furthermore, if the participants were concentrate enough while repairing Villa Serena, they were able to breathe in time to a breathe visual cue (a blue butterfly). This assisted their HRs to fall into a resonant frequency which was known as Coherence. At this strongest and most stabilizing state, there were many positive changes happened in the body and helped participants clear their mind to achieve a natural state of balance.

There were five difficulty levels in total offered in Villa Serena, which were "Very Easy" (40% Coherence), "Easy" (60% Coherence), "Normal" (70% Coherence),

"Difficult" (85% Coherence), and "Very Difficult" (95% Coherence). The higher the difficulty level, the more breath cycles were needed to complete the task. "Normal" level was suggested in this study, thus the participants were required to achieve 70% Coherence to restore Villa Serena successfully (Wild Divine, n.d.). Besides, the breathing cycle was offered in a range from 8 to 14 seconds in Villa Serena. The breathing cycle with 8 seconds was set according to the specific needs of participants in this study.

The "Visual Breathing Cue" referred to a blue butterfly. Its wings opened and closed repeatedly to guide the participants about breathing pattern. This breathing pattern affected their HR variability and coherence scores in repairing Villa Serena. The participants needed to inhale when the butterfly's wings opened and exhale when the wings closed. Also, they were instructed to adjust their breathing gently to avoid feeling uncomfortable or unnatural while playing the game. They had to let their bellies expanded gently when they inhaled and contracted gently when they exhaled. This was because "trying harder" would not help participants meet relaxation goals effectively.

Plate 1 Outside of Villa Serena.

Plate 2 Inside of Villa Serena.

Microsoft Minesweeper. Microsoft Minesweeper (Kaye, 2000) is a classic puzzle game of Microsoft Windows. It was employed as the game for the control group in this study. The participants were shown an initially all blank grid in the game. There might be a number, flag or bomb hiding under each grid. Participants selected each grid randomly or according to the number given throughout the game. They won the game if they never clicked on the bomb until the end of the game. They lost if they clicked on the bomb, then they had to replay it.

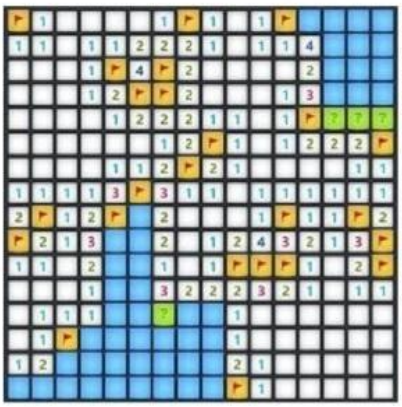

Plate 3 Microsoft Minesweeper.

Wild Divine Iom Hardware. Wild Divine Iom active feedback hardware is a lightweight hardware device that is used to measure an individual's HR (Schuller, Friedmann, & Eyben, 2013). It was connected to the computer with Windows 10 Pro by using a USB. Concurrently, it was paired with the pulse finger sensor that was connected to participants' fingertips to detect their pulse rates while they were playing Villa Serena.

Participants' HRs were shown in the Wild Divine Iom Grapher that expressed as beats per minute (bpm). The HRV, which is the variation in the beat-to-beat interval, was calculated.

Plate 4 Wild Devine Iom Hardware.

Research Procedures

Consent. A consent form was given to the participants as they got into the laboratory. They were informed about risk and discomfort as well as the benefits of participating in this study. Voluntary participation and available medical treatment in this study were explained too. Additionally, participants were informed that they would be blinded throughout this study. They were required to read through an "Instructions" paper

to get the instructions of what they should do in this study. Ten minutes were given to the participants for reading through the consent form and leaving a sign if they agreed to proceed and actively participate in this study.

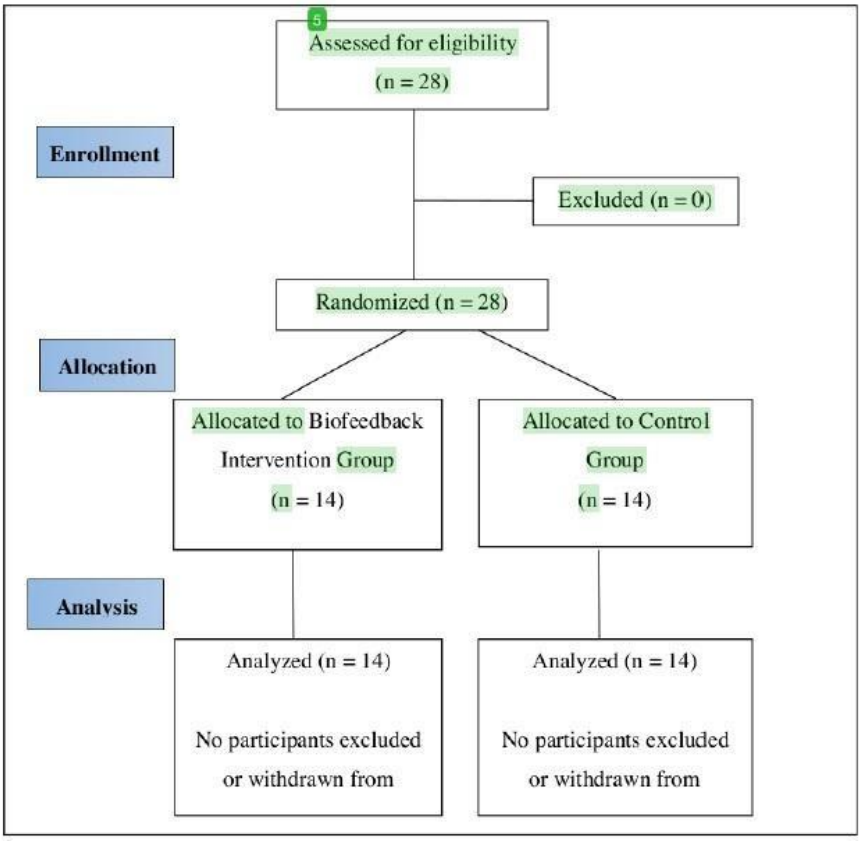

Figure 2 The diagram illustrated the randomized controlled trial (RCT) in this study.

Pre-test measurement. Before proceeding to the intervention, participants were requested to fill in a self-administered questionnaire which consisted of the demographic questionnaire, the PANAS, and the STAI (STAI S-Anxiety scale and STAI T-Anxiety scale). They were given 15 minutes to complete the questionnaire. Then, participants were randomly assigned to either the intervention or control group by using an online random sequence generator. Participants who got an even number were assigned into the intervention group while those who got an odd number were assigned into the control group.

Biofeedback intervention group. Participants in intervention group were instructed to play a biofeedback game which was Villa Serena. Before starting playing game, pulse finger sensor was connected to the participants' fingers to detect their pulse rate. Iom sensor signal on Villa Serena should be showing Green/Good to ensure that the sensor was connected and functioning well. Then, participants were given 45 minutes to play Villa Serena. The HRs of participants, while they were playing Villa Serena, were recorded in Wild Devine Iom Grapher. The records of participants' HR were saved as a photo and PDF file individually for the purpose of result analysis.

Control group. Participants in control group were directed to play Microsoft Minesweeper game. Medium mode was selected for this study. Before playing the game, pulse finger sensor was connected to the participants' fingers to detect their pulse rate. Participants were offered 45 minutes to play Microsoft Minesweeper. Their HRs, while playing Microsoft Minesweeper, were recorded in Wild Devine Iom Grapher. Their HRs' records were saved as a photo and PDF file individually for result analysis purpose.

Post-test measurement. After the intervention, participants were requested to fill

in a self-administered questionnaire which contained the PANAS and the STAI (STAI S-Anxiety scale and STAI T-Anxiety scale). They were given 15 minutes to complete it. Then, participants were debriefed about this study's objective. They were also promised that their private information and HRs would be kept confidential and would not be exposed to the third party. Moreover, participants were requested to keep a promise of what they had known about this study to avoid the exposure of this study's details to other students.

Data Analysis

The demographic, the PANAS and the STAI data were collected by adopting pen-and-paper surveys. HRV was collected by Wild Divine Iom Hardware and data were obtained from Wild Divine Iom Grapher. All data were analyzed using JASP 0.11.1 software. Analysis of covariance (ANCOVA) was employed to analyze the data of pre-test and post-test for both the intervention group and the control group. ANCOVA is a mixture of analysis of variance (ANOVA) and regression which is used to examine the differences between the means of dependent variables in multiple groups while taking into consideration the effects of covariates on dependent variables (Sampson, 2018).

The normality test was accomplished to examine if the dataset were well-modeled by a normal distribution. The normality test was achieved by performing a Q-Q plot (Sampson, 2018). Q-Q plot illustrates the quantiles of the data in a distribution plot instead of a normal distribution graph. If all the points are close to the reference line, the Q-Q plot shows that the data are normally distributed. However, if the points are "sag" or snake around the reference line, the Q-Q plot represents that the data are not normally

distributed (Sampson, 2018).

Homogeneity of variance test was accomplished to examine if the variances were equal across different groups. Homogeneity of variance test was achieved by performing Levene's test (Sampson, 2018). The result of Levene's test is presented as a *p*-value. If the *p*-value is not significant ($p>.05$), the test shows that the variances across different groups are equal. However, if the *p*-value is significant ($p<.05$), the test represents that the variances across different groups are unequal (Sampson, 2018).

Chapter 4

Findings and Analysis

Adjustment of Outliers

There was no outlier being adjusted in this study as there was no significant outlier being identified in this study.

Normality of Data

The distributions of the points of PA, NA, STAI S-Anxiety, STAI T-Anxiety and HRV data in both intervention and control group were close to the reference lines in Q-Q plots (see Appendix). The results showed that the data of PA, NA, STAI S-Anxiety, STAI T-Anxiety and HRV in both intervention and control group were normally distributed.

Homogeneity of Variance

From table 4.1, all the p-values in Levene's tests are not significant ($p>.05$), showing that the variances of all data across intervention and control group are equal.

Table 4.1

The p-value of Data in Both Intervention and Control Group

	p-value
PA	.522
NA	.202
STAI S-Anxiety	.515
STAI T-Anxiety	.329
HRV	.186

Positive Affect (PA)

ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-PA controlling for Pre-PA. The covariate, Pre-PA, was not significantly related to the Post-PA, $F(1,25) = 3.329$, p=.080, ω^2 = 0.078. There was also no significant effect of biofeedback game on Post-PA after controlling for Pre-PA, $F(1, 25) = 0.432$, p=.517, $\omega^2 = 0.000$.

Table 4.2

ANCOVA for the Difference between Games on Post-PA Controlling for Pre-PA

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	35.618	1.000	35.618	0.432	0.517	0.000
Pre-PA	274.786	1.000	274.786	3.329	0.080	0.078
Residual	2063.286	25.000	82.531			

Note. Type III Sum of Squares

Negative Affect (NA)

ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-NA controlling for Pre-NA. The covariate, Pre-NA, was significantly related to the Post-NA, $F(1,25) = 20.619$, $p<.001$, $\omega^2 = 0.420$. There was no significant effect of biofeedback game on Post-NA after controlling for Pre-NA, $F(1, 25) = 0.139$, $p=.713$, $\omega^2 = 0.000$.

Table 4.3

ANCOVA for the Difference between Games on Post-NA Controlling for Pre-NA

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	3.921	1.000	3.921	0.139	0.713	0.000
Pre-NA	583.601	1.000	583.601	20.619	< .001	0.420
Residual	707.613	25.000	28.305			

Note. Type III Sum of Squares

15

State-Trait Anxiety Inventory (STAI) State Anxiety (S-Anxiety)

ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-STAI S-Anxiety controlling for Pre-STAI S-

Anxiety. The covariate, Pre-STAI S-Anxiety, was not significantly related to the Post-STAI S-Anxiety, $F(1,25) = 12.630$, $p=.002$, $\omega^2 = 0.301$. There was no significant effect of biofeedback game on Post-STAI S-Anxiety after controlling for Pre-STAI S-Anxiety, $F(1, 25) = 0.016$, $p=.900$, $\omega^2 = 0.000$.

Table 4.4

ANCOVA for the Difference between Games on Post-STAI S-Anxiety Controlling for Pre-STAI S-Anxiety

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	1.470	1.000	1.470	0.016	0.900	0.000
Pre-STAI S-Anxiety	1150.447	1.000	1150.447	12.630	0.002	0.301
Residual	2277.124	25.000	91.085			

Note. Type III Sum of Squares

State-Trait Anxiety Inventory (STAI) Trait Anxiety (T-Anxiety)

ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-STAI T-Anxiety controlling for Pre-STAI T-Anxiety. The covariate, Pre-STAI T-Anxiety, was significantly related to the Post-STAI T-Anxiety, $F(1,25) = 67.972$, $p<.001$, $\omega^2 = 0.697$. There was no significant effect of

biofeedback game on Post-STAI T-Anxiety after controlling for Pre-STAI T-Anxiety, $F(1, 25) = 2.115$, $p=.158$, $\omega^2 = 0.012$.

Table 4.5

ANCOVA for the Difference between Games on Post-STAI T-Anxiety Controlling for Pre-STAI T-Anxiety

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	88.066	1.000	88.066	2.115	0.158	0.012
Pre-STAI T-Anxiety	2829.985	1.000	2829.985	67.972	< .001	0.697
Residual	1040.872	25.000	41.635			

Note. Type III Sum of Squares

Heart Rate Variability (HRV)

ANCOVA was conducted to identify a statistically significant difference between biofeedback game and puzzle game on Post-HRV controlling for Pre-HRV. There was a significant effect of biofeedback game on Post-HRV after controlling for Pre-HRV, $F(1, 26) = 88.665$, $p<.001$, $\omega^2 = 0.758$.

Table 4.6

ANCOVA for the Difference between Games on Post-HRV Controlling for Pre-HRV

Cases	Sum of Squares	*df*	Mean Square	*F*	*p*	ω^2
Games	3521.286	1.000	3521.286	88.665	< .001	0.758
Residual	1032.571	26.000	39.714			

Note. Type III Sum of Squares

Discussion

Previous studies noted Biofeedback game improved emotional regulation and reduce anxiety by training the respiration rate into a relaxation state (Fagundo et al., 2013; Knox et al., 2011; Schoneveld et al., 2016), it was hypothesized that participants will show that the biofeedback game, Villa Serena, will have significant effects on PA, NA, STAI-S, STAI-T scores and HRV. However, the ANCOVA showed that the difference between the Villa Serena intervention group and the Minesweeper active control group for PA, NA, STAI-S and STAI-T results were not statistically significant, while the only statistically significant result between the Villa Serena intervention group and the Minesweeper active control group are the HRV.

Positive Affection and Negative Affection

The PA and HRV are not necessarily showing the significant interaction between HRV coherence and positive affect (Kim et al., 2018; Kotozaki et al., 2014). A study with 20 session shows that breathing technique can have no between-group difference effect on the PA, and concluded that the time point for the significant reduction of NA occurs is unknown (Ma et al., 2017). This result may be explained by the fact that a significant reduction of NA does not immediately occur for the first session. This further supported by a one-session breathing technique training that produces a similar result for NA, which intervention group is no significant difference with the sham group (Johnson, Gur, David, & Currier, 2013). A note of caution is due here since there has statistical significance for both pre and post group in NA, the effectiveness of Villa Serena on reducing the NA remain unconcluded. Hence, this combination of findings provides some support for the conceptual premise that the reduction of NA may need multiple session to occur as significant.

Anxiety

A study on the effectiveness of respiratory-sinus-arrhythmia biofeedback on state-anxiety, show that it's possible to show a result that is statistically significantly decreased in both intervention and control groups (Mikosch et al., 2010). This is presumably correlated with stress reduction and/or emotional relief after the experiment had been completed. In a similar Biofeedback training that further tracking the physiological symptoms, it has shown a comparable result that anxiety score has no significant difference from no-intervention control after the intervention (Kotozaki et al., 2014). This observation may support the hypothesis that the reduction of anxiety may need long

period training to be significant. As supported by the detailed table from research that shows signs of the game treatment start taking effect on threating anxiety from the third session (Schoneveld et al., 2016). However, with small sample size, caution must be applied, as the findings might not be able to apply to the general public and general bio-feedback game treatment. This finding has important implications for developing a future biofeedback game treatment studies on anxiety. Hence, further studies, which take these variables into account, will need to be undertaken.

Heart rate variability

A strong relationship between Heart rate variability and Biofeedback game has been reported in the literature. The current study found that as a game that aims to train the breathing technique and leading to HRV coherence, Villa Serena is performing significantly better than the Minesweeper control group. These results are in line with those of previous studies (Fagundo et al., 2013; Kim et al., 2018; Sutarto, Wahab, & Zin, 2010). The present study raises the possibility that biofeedback game, Villa Serena can be useful as a tool to enhance the stable physiological symptoms in term of HRV coherence.

In summary, these findings will doubtless be much scrutinized, but there are some immediately dependable conclusions for HRV coherence. We hypothesize that short and consistent training sessions will be showing the more statistically significant result, meanwhile long and one-time training session, will show no statistically significant result when comparing with the control group. Hence further research should be undertaken to investigate the effectiveness of the biofeedback game in short one session.

Limitation and Recommendation

This study was faced with some limitations and must be acknowledged. Firstly, the participants may lose their attention towards the game in such a long gameplay session. It may influence the gaming experience of participants and the result of the study. Secondly, the time limit for every gameplay session is not standardized for every participant, which is 5 minutes at most less than expected. An unstandardized time limit means that the 45-minutes gameplay session is incomplete and not meeting the target. The Iom finger Grapher fails to detect the pulse consistently due to unknown reason, thus causing unstandardized time measurement to occur in the result. Thirdly, the sample size for this study is small which can limit the significance of the result. The purposive sampling method is used as the samples are only recruited in UTAR, one specific university in the northern peninsula of Malaysia, which limits the effect of generalization to the population (Knapp, 2016).

Throughout this study, there are some recommendations suggested for those who are interested in this topic. Firstly, a 45-minutes gaming session was conducted for each participant to collect their heart rate variability data. Therefore, there is a need to reduce the duration of sessions in order to explore the significant effectiveness of the biofeedback game. Secondly, there is a need for using another biofeedback device for pairing the originally used biofeedback device (Wilson, 2009). For instance, an ear-clip Iom device developed by Unyte Health Inc. (formerly known as Wild Divine). It can also measure the heart rate variability and it is simple to use. Thirdly, a probability sampling method can be adopted instead to repeat this study. It can decrease the sampling bias when recruiting participants from different states in Malaysia. Thus it can include

diversified potential participants to improve the accuracy and generalizability of the result to the target population (Knapp, 2016).

Conclusion

In summary, this study aimed to investigate the effects of biofeedback game on affection and anxiety among undergraduates. This study comes up with important sources regarding the biofeedback game and its effect on affection and anxiety in undergraduate students. This study clarifies that the psychological aspects of emotions can affect the physiological aspects of the body. The findings indicate that heart rate variability has a statistically significant difference from the control group. All of the variables have significant differences between pre and post-test, except for positive affect. This study provides a great direction for future researchers to establish the full potential of biofeedback games as a kick-starter affective game for the target population.

FYP 2

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Action Plan of UAPZ 3023 (group-based)Final Year Project II for Jan & May trimester

Supervisee's Name: Ling Gong Shuen, Ng Kuan Sien, and Tan Pei Chin

Supervisor's Name: Mr. Pheh Kai Shuen

Task Description	Duration	Date/Time	Supervisee's Signature	Supervisor's Signature	Supervisor's Remarks	Next Appointment Date/Time
Methodoloty, Data Collection & Data Analysis	W1-W2	3/2/2020 12p.m.				13/3/2020 11:30a.m.
Finding & Analysis Discuss Findings & Analysis with Supervisor Amending Findings & Analysis	W3-W6	13/3/2020 11:30a.m.				13/3/2020 6p.m.
Discussion & Conclusion Discuss Discussion & Conclusion with Supervisor Amending Discussion & Conclusion	W7-W9	13/3/2020 6p.m.				
Submission of first draft*	Monday of Week 10	submit the first draft to Turnitin.com to check similarity rate				
Amendment	W10					
Submission of final FYP (FYP I + FYP II)*	Monday of W11	submit hardcopy, CD, and relevant documents to supervisor				
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Notes:
1. The listed duration is for reference only, supervisors can adjust the period according to the topics and content of the projects.
2. *Deadline for submission can not be changed, one mark will be deducted per day for late submission.
3. Supervisees are to take the active role to make appointments with their supervisors.
4. Both supervisors and supervisees should keep a copy of this rec5. This record is to be submitted together with the submission of the FYP II.

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UAPZ 3023 Final Year Project II

Research Project Evaluation Form

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Supervisor: Mr. Pheh Kai Shuen	
Student's Name: 1. Ling Gong Shuen 2. Ng Kuan Sien 3. Tan Pei Chin	Student's Id 1. 16AAB02362 2. 17AAB05101 3. 16AAB02253

INSTRUCTIONS:

Please score each descriptor based on the scale provided below:

1. For criteria **1, 2, 3,4, 5, 6**:
   0 = no attempt, 1 = very poor, 2 = poor, 3 = average, 4 = good, 5 = very good

2. For criteria **3,4**:
   0 = no attempt, 1 = very poor, 3 = poor, 5 = average, 7 = good, 10 = very good

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1. ABSTRACT (5%)	**Score**
1. States clearly the research objectives. (5%)	
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Subtotal (*Sum* /5)	**/ 5%**
Remark:	
2. METHODOLOGY (20%)	
1. Appropriate research design/framework (5%)	
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