DEDICATION

Specially dedicated to
My beloved family and those who have
Encourage and always be with me during hard times
And inspired me throughout my journey of learning

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ABSTRACT

This thesis presented about analysis of aiming technique in archery shooting for the enhancement of archery sports in Malaysia. Before this, engineering in sport was not popular as many people did not realize the important of engineering factors in sports. It was not discovered and most of the athletes depend on the experienced and their practice in order to achieve their target. This study will be focusing on the aiming part and the factors that will affect the aiming and concentration of the archery athletes. Based on this study, there are a few factors that will be determined to be the cause for the distraction of the aiming phase. Corresponds to the project background and problem statements, it is decided that the objectives of the project are to analyse the aiming techniques from archery athletes, to study the relationship between the heart rate and emotions with the performance and to relate the aiming time with the shot points. The results from the analysis of heart rate proved that lower heart rate will distribute to a higher score. From the biofeedback device, the emotions level showed a distraction to the performance of the athletes. The increase of stress level can cause a lower accuracy during the aiming phase and will distribute to a lower score. For the aiming time, three parameters have been set up which are 3, 5 and 7 seconds. From this aiming time, the best total score is during the aiming time in 5 seconds.

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ABSTRAK

Tesis ini membentangkan tentang analisis mengenai teknik sasaran dalam memanah untuk memperkuatkan mutu sukan memanah di Malaysia. Sebelum ini, kejuruteraan sukan tidak begitu terkenal dan ramai pihak yang tidak sedar akan kepentingan aspek kejuruteraan dalam sukan.Ia tidak dikaji dan kebanyakan atlet bergantung kepada pengalaman dan latihan untuk mencapai sasaran mereka. Kajian ini akan bertumpu kepada peranan teknik sasar dan juga faktor yang akan mengganggu konsentrasi atlet memanah. Berdasarkan kajian ini, terdapat beberapa faktor yang akan diketengahkan sebagai punca kepada gangguan ketika memanah. Berdasarkan latar belakang projek dan pernyataan masalah, objektif untuk projek telah dibuat iaitu analisis mengenai teknik sasaram daripada atlet memanah, mengkaji hubungkait antara degupan jantung dan emosi dengan prestasi dan juga mengkaji waktu sasar dengan skor. Hasil daripada analisis degupan jantung membuktikan bahawa degupan jantung yang rendah akan membantu kepada prestasi yang lebih baik. Daripada alat biofeedback, paras emosi menunjukkan gangguan kepada prestasi seseorang atlet. Penambahan paras tekanan akan menyebabkan ketepatan yang rendah semasa fasa sasaran dan akan menyebabkan skor yang rendah. Untu masa sasaran, 3 parameter telah ditetapkan iaitu 3, 5 dan 7 saat. Daripada masa sasaran tersebut, jumlah skor terbaik adalah ketika masa sasaran 5 saat.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Archery is one of the shooting sports that require the uses of bow and arrow. In archery, the bow is used to hold and shoot the arrow at a target board. Archery is a sport which propels arrows with a bow to the target. (Lee, 2009). Long years ago, the bow and arrow were created to find a food by hunting an animal and later it became a weapon of warfare. But nowadays, archery has become one of the most popular sports and known worldwide. There are different types of archery but the most popular types are target, field and clout archery.

Target archery is the only type of archery that allowed in the Olympic games. It involves the shooting fixed number of arrows at a target from a specific distance. All types of bow which is longbow, barebow, recurve and compound can be used in target archery. In target archery, the target is circular with 10 concentric rings. For field archery, it involves shooting at targets of marked and unmarked distance which is will be shoot in a flat field. The objective of field archery is to improve the techniques and abilities required for bow hunting in a more realistic outdoor setting. For clout archery, it is a form of archery which the archers shoot an arrow at a flag from a long distance and the score points depends on how close the arrow lands to the flag.

In archery tournaments, it may be held indoors or outdoors. For indoor round, normally it will involve shooting at a one distance only while outdoor tournament consists of more than one distance. The Federation Internationale de Tir a Arc (FITA) was introduced during 1930's which act as the governing body for the sport and at that

time the international rules were created. In FITA rules, there are standard distances for the indoor and outdoor sports. For indoor sports, the standard distance is 18m to 25m while for outdoors, the distance range from 30m to 90m. But in the Olympic Games, it used 70m.

1.2 PROJECT BACKGROUND

Archery has become one of the oldest art but still being practiced until today. Long years ago, archery was very famous as one of the tools of war. But nowadays, archery is one of the most important sport in all countries. Archery is known as a static sport that required strength and stability especially on the upper part of the body. Archery consists of a bow and arrow, also a target board for the archer to shoot. This target board will determine the performance of an archer. The score of each arrow depends upon where it lands on the target. The highest score is achieved by shooting an arrow at the center of the board. In archery, scoring has become the most important aspect of this sport (Hwang, 2004). There are various aspects that will affect the scoring part. For instance, the environment, concentration and the heart rate of an archer.

The sport of archery does not only focus on the strength of the athlete. Sometimes we might think that the archery athlete should have a good strength in order to have a good performance but physically fit is not enough in archery sport. This is because in archery it involves the mental focus and need full of concentration to achieve a good performance. Mental concentration accompanied by visual focusing plays an especially key role in performance (Lee, 2009). Concentration is one of the key factors to success in archery. The athlete has to focus and relax their minds in order to develop the archery skills and control the mental toughness to make a good shot. In sports that require accuracy, higher level of arousal can decrease the performance of the participants (Filipe Clemente, 2011). Nobody can concentrate all the time, but whatever did we do, the peak concentration is normally only possible for relatively short times. For the athlete, what they can do is to choose when those times are. For target archery, full concentration is only critical for about 10 seconds at a time during each shot.

1.3 PROBLEM STATEMENT

Since archery has become the important sport in the Olympics and other tournaments, archery technique was being analyzed to improve the performance of an archer. There are several factors that will affect the aiming technique of an archer such as the concentration, heart rate and the aiming time of the archer. However, do the factors really affect the performance of the athlete? So, we need to analyze those factors to the archery athlete in order to improve the performance.

1.4 OBJECTIVES OF THE PROJECT

Corresponds to the project background and problem statements, it is decided that the objectives of the project are:

(i) To analyze the aiming techniques from archery athlete
(ii) To study the relationship between heart rate and emotions with the archery performance
(iii) To relate the aiming time with the shot point

1.5 SCOPES OF THE PROJECT

This project is focusing on the analysis of aiming technique which analyzes the factor that will affect and improve the aiming technique of an archer. This focus area is done based on the following aspect:

(i) Focusing on the aiming technique
(ii) Different level of athlete which is experienced and less experienced archers
(iii) Heartbeat of an archer
(iv) Concentration of archery athlete during the aiming phase
(v) Aiming time will be set for 3, 5 and 7 seconds

1.6 EXPECTED OUTCOMES

For this project, the expected outcomes are very useful for next Malaysian Archery Athletes to increase the performance of athletes from the aiming technique.

(i) Present and proposed the study results
(ii) Compare the study results with previous research
(iii) Suggest the best option for the aiming technique in order to increase performance

1.7 STRUCTURE OF THESIS

Chapter 1 introduces the introduction and background of the study. It discusses about the introduction about archery sports and the technique in archery shooting which focuses on the aiming technique. Besides, this chapter also comes out with problem statement which related to the study, the objectives, scope of the study, the expected outcomes and the structure of the thesis.

Chapter 2 presents the literature review that focus on the research study which related to the aiming technique and criteria that will affect and disturb the aiming phase and concentration of the archer. Besides, this chapter also helps to propose the methodology on how to conduct the experiment and the number of athletes that will be tested for this project.

Chapter 3 includes all the methods on how to conduct and run the experiment of the study. This chapter also includes the number of subjects that will do the experiment, the device and equipment that will be used and the parameters that will measure. It will explain the flow of the methodology from the flowchart and discuss the way to conduct on the procedure of the experiment.

Chapter 4 focuses on the results and discussions of the research. The analysis of the biofeedback device will be conducted in this chapter. The results that will be analyzed from this chapter are the archer's heart rate, emotions and aiming time to be related with the shot points. The expected results from this research will be less aiming time will result in better shot point, and the lower the heart rate of the archers, the higher the accuracy of the archers.

Chapter 5 presents the conclusion of this project and the recommendations that will beneficially for future works progress.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will cover the academic information about the process flow of the project. The chapter starts with the introduction of the techniques in archery which focusing on the aiming part and factors that affect the technique will be discussed to guide through this project. Chapter two also covers about the concentration and heart rate of the athlete during the archery tournament.

2.2 IMPACT OF ATTENTION

Attention refers to how the specific information presented in our environment will be actively processed. There are two types of attention which is the passive and active attention. For passive attention, it refers to the involuntary process from the external events that come from the environment such as bright flash or sudden loud noise. For active attention, it is guided by the alertness, concentration, interest and needs such as curiosity and hunger. Effort will be involved in active attention. In sports, attention is very important to have a better performance and better result. For acquiring new skills, athletes prefer to adopt the internal and external attention. Internal attention focusing on the body positions or movements and external attention focusing on effect of these positions or movements (Shana, 2012).

2.3 AIMING IN SPORTS

In sports, there are a lot of things that we need to consider in order to perform well and have a better performance. There are many types of sports such as shooting, cycling, soccer and many more. Each sport has their own characteristics and way on how to achieve the target and control the game. In sports, aiming and concentration is a very important criteria to be considered especially sports that require full concentration to score such as archery, shooting, golf, cricket and so on. For this type of sports, aiming and concentration will be the main factor to have a perfect score. Without the full concentration for the aiming phase, it will affect the performance and the score of the athlete. Target shooting is a sport of extreme precision where the athlete's skill is measured by how close to the center and how often the athlete's shots hit the target.

2.4 RIFLE SHOOTING

Rifle shooting is one of the shooting sport that are very complex and need an accuracy and speed. The more consistent in shooting, the more accurate it will become. (Lee, 2009). Without a doubt, consistency is the key to accuracy. Accuracy of the shooting can be achieved if getting the exact same conditions for each shot, right down to the cleanliness and temperature of the barrel. Besides, in rifle shooting, the postural balance and the rifle stability also play an important role to have a good aiming and improve the shooting performance. Simo Ihalainen (2012), stated that better postural stabilty helps international level air rifle shooters to hold the rifle more stable compare to the national level shooters. Once the athletes have the stability, they can focus and concentrate more on the aiming part and give the best performance.

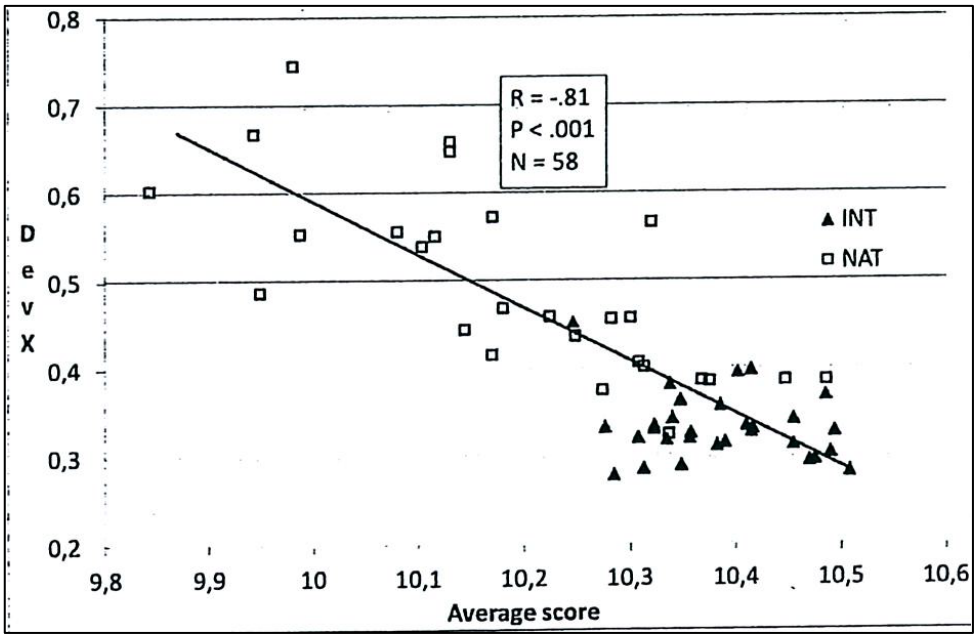

Figure 2.1: Relationship between aiming point trajectory in horizontal direction (DevX) and average score

Source**:** Simo Ihalainen, 2012

Figure 2.1 shows the relationship between aiming point trajectory in horizontal direction (DevX) and average score. In this study, fifteen air rifle shooter, 10 from women and 5 men performed in total of 58 simulated competition series of shots which women 40 shots and men 60 shots during various testing occasions. The data recorded in this study was the shooting score, aiming point trajectory and center of pressure (CoP) movement. Four shooters that regularly participating in world cup competitions were considered as an international level shooter and need to do 30 tests and other shooters formed a national level group and need to do 28 tests. The relationship between the postural balance and the rifle hold were analyzed. From the results, international have a higher average score than national group which demonstrated that better postural stability give more stable rifle hold to the international group compared to the national group.

2.5 PISTOL SHOOTING

Pistol shooting is almost the same like the rifle shooting. The difference between these two sports are the size of the gun and the way to shoot into the target. For pistol shooting, it might be different from the way on how to hold the pistol compare when holding the rifle. The rifle has to be a little bit heavier than the pistol so it will affect more on the concentration of the athletes. To determine the effects of the accuracy for pistol shooting, the shooter experienced, postural body, and the cognitive aspects of the aiming task need to be considered (Ravindra S. Goonetilleke, 2009).

2.5.1 Shooting Aiming Technique

Two strategies will be used for the shooting aiming technique which is the first strategy is the gaze will be fixed on the target and the weapon was brought to the direction of the gaze (Raynaud, 1980) as cited in (Ravindra S. Goonetilleke, 2009). For the second strategy, focusing on the weapon and visually assisting its positioning as suggested by Rouquier and Prouzet (1978).

2.5.2 Effects of Shooter Experience

From a study of expert shooters and pentathletes, Ripoll et al. (1985) found that expert pistol shooters will use both of the strategies, whereby the gaze is between the weapon and the target and the weapon is brought towards the target without any visual support. For a non-experts shooter, they tend to use the second strategy by using visual support for weapon movement. Due to these differences, it was found that there is approximately a 0.5 s difference in the final adjustment of gaze onto the target (Ripoll et al.,1985)

2.5.3 Effects of Postural Balanced

From the rifle shooting, it has been proved that the postural balanced and the stability of the weapon will affect the aiming phase. For novices or inexperienced shooters, the postural balance and weapon stability tend to be different for whom disturbances to postural balance cause increases in gun movement (Mononen et al., 2007). Experienced shooters can stabilize their postures quite well during the last 1.5 s preceding a shot and are thereby quite different from their inexperienced counterparts (Era et al., 1996) as cited in (Ravindra S. Goonetilleke, 2009).

2.5.4 Effects of Heart Rate

The heart rate also can affect the performance of the shooter because it can distract the concentration during the aiming part. Patsy Tremaynea (2000), study the comparison of the patterns of physiological activity in elite pistol shooters and novice shooters. For the study, heart rate and electrodermal activity were recorded for three 150-s epochs. It involves 10 Master and A-Grade shooter for experts, nine males and one female, and 10 novice shooter, also consists of nine males and one female. Participants performed part of the Standard Pistol Shooting Protocol, firing five rounds at a target 25 m distant within the first 150 s epoch. For each shot, values of heart rate and skin conductance were calculated at half-second intervals from 20 s before to 10 s after the shot.

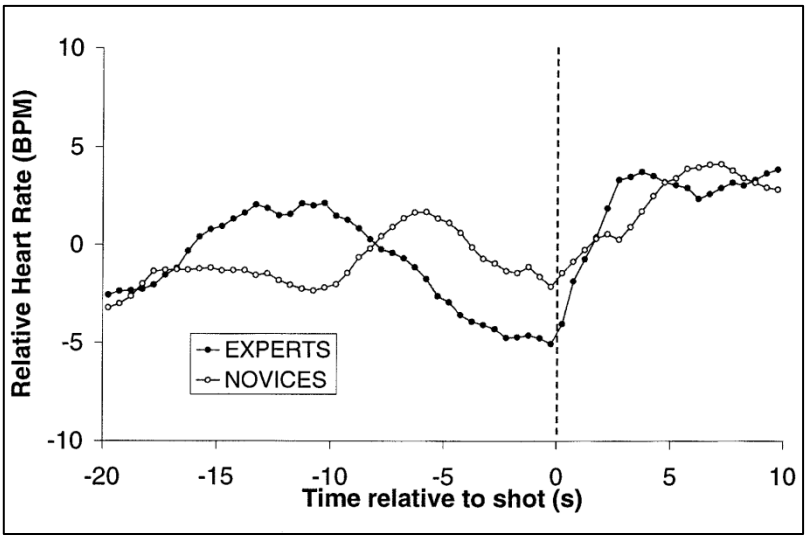

Figure 2.2: Relative mean heart rates at 0.5-s intervals from 20 s before to 10 s after the shot in both expert and novice shooters.

Source: Patsy Tremaynea, 2000

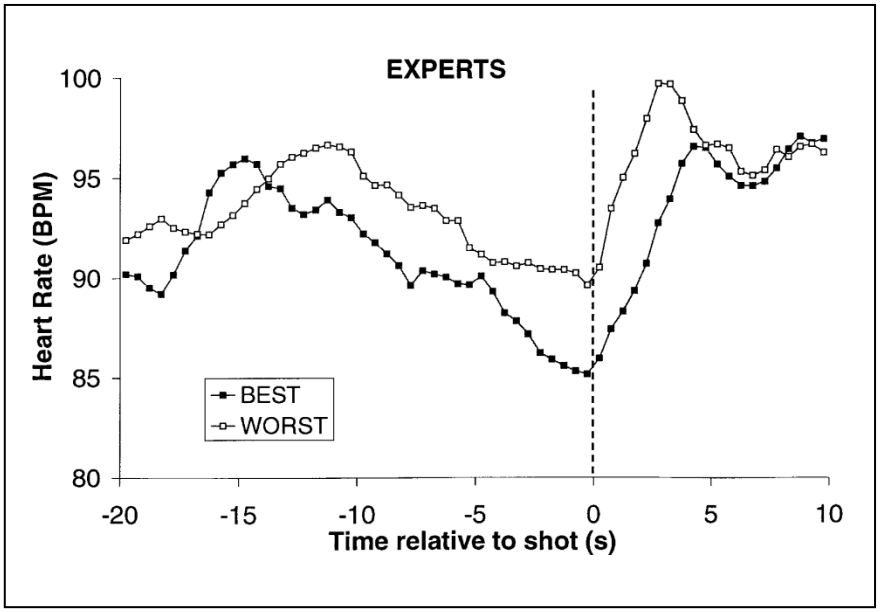

Figure 2.3: Heart rate profiles in the expert shooters for best vs. worst shots

Source: Patsy Tremaynea, 2000

From the results, there were no fluctuation in anxiety levels for the experts from the three conditions which is before, between and after the shooting epochs. The anxeity level can effect the performance score because when the anxiety level increase, it might increase the arousal level and distract the shooter concentration. In experts there was a slow reduction in skin conductance and heart rate levels prior to the shot, and a rebound increase immediately following the shot, which were not apparent in the novice shooters.

2.6 GOLF

In golf sport, the athlete must have a very high concentration during the games because this game requires precision to score a high marks. For golf athletes, concentration and the aiming part have to be good for a better performance. Besides, in golf sports, heart rate has also played an important role in order to have a good performance. From previous studies, David L. Neumann (2009), proved that performance was better in elite and experienced golfers than in novice golfers. From the study, it involves 19 elite golfers aged from 16 to 34 years who are a professional golfer competed in the international golf competition, 16 experienced golfers aged from 19-41 which were recruited from local clubs and 17 novice golfers aged 17-41 which had no prior experience in playing golf or mini golf. The electrocardiogram (ECG) was used to measure the cardiac activity of the golfers.

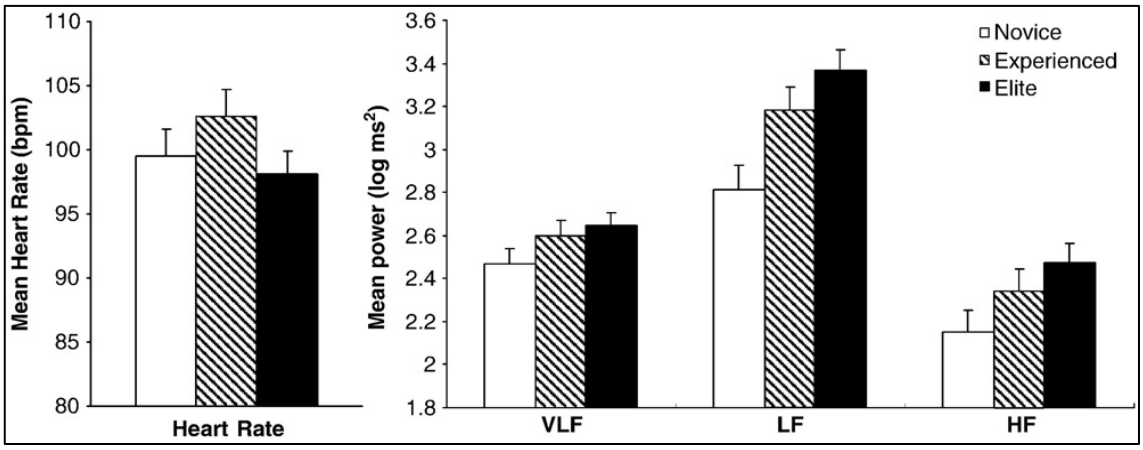

Figure 2.4: Mean heart rate (left panel) and mean spectral power for the very low frequency (VLF), low frequency (LF), and high frequency (HF) components for heart rate variability (right panel) in the novice, experienced, and elite groups

Source: David L. Neumann, 2009

Table 2.1. Classification of the respiratory patterns immediately prior to the putt for the novice, experienced, and elite groups averaged across all putting conditions

Respiratory pattern	Group		
	Novice	Experienced	Elite
Inhaling	69%	25%	17%
Holding	25%	31%	11%
Exhaling	6%	44%	72%
Total	100%	100%	100%

Source: David L. Neumann, 2009

From the study, it showed that elite, experienced and novice golfers show some similarities, but also some differences in their patterns of cardiac and respiratory activity. Performance was better in elite and experienced golfers than in novice golfers. Compared to novice golfers, the experienced and elite golfers showed a pronounced phasic deceleration in heart rate immediately prior to the putt, greater heart rate

variability in the very low frequency band, and a greater tendency to show a respiratory pattern of exhaling immediately prior to the putt.

2.7 ARCHERY

Archery is an interesting competitive sport. Archery was very popular around the world and not just a tool of war and hunting, but survived as an element of entertainment. Archery is a type of sport that is involved in the Olympic Events. Higher performances in Olympic events can be defined as the ability to shoot at a given target with high accuracy (Ertan H, 2005). Archers need strength as well as the ability to concentrate in order to aim and shoot successfully. Besides, archers also need some skills in order to have a good performance. Skill in archery is defined as the ability to shoot an arrow at a specific time with high accuracy (Leroyer P, 1993).

One of the most critical aspects that help for a better performance in archery was the aiming phase. Archers need to stay calm and have full concentration in order to aim very well. In sports, archery can be defined as one of the sports that require a high level of mental concentration (Lee, 2009). This kind of sports involves high mentality and full concentration from the athletes. During archery tournaments, there is a lot of pressure from the environment such as the noise, weather and stress from the audience. The athletes need to keep focus during the aiming phase and keep calm before releasing the arrow.

Therefore, the archer must get out of anxiety during the tournament especially when in a big tournament like the Olympics. This is because the anxiety symptoms are connected to the stress of participation in sports. Anxiety is an apprehensive anticipation or fear by the individual of some risky occurrence in the future. Anxiety is usually accompanied by unpleasant emotional state, stress or tension, and somatic symptoms and signs (Dilip R. Patel, 2010). The archers should not lose concentration by external noise or internal thought distractions like anxiety and should concentrate only on the shooting process (Lee, 2009).

2.7.1 Aiming In Archery

For archery athletes, the aiming part is important in order to have a good performance. To shoot a bow accurately the athlete has to be able to pick a specific target and properly loose an arrow in such a way that the arrow hits the intended target. The process of designating the spot that the archer wants to hit and positioning the bow to do so is called aiming. There are a lot of things that the athlete needs to focus on to make sure that they will have a better aiming technique. The aiming and expansion phase of the shot sequence should be a very short interval of time and should be subconscious rather than conscious. Beginning to aim too early will distract the archer from the feel of the shots and reduce consistency. The archery performance can be improved by shortening the elongated aiming time, especially those with low scores (Hwang, 2004).

During the aiming part the archers should focus on the internal process of the shot. The archer has to remain relaxed and focus on the target for a better performance. In competition, selective attention in the shooting will be important since there are many noises, tensions and anxiety (Lee, 2009).In archery, despite of having good skills and strength, aiming also need to be considered as long as to maintain a good performance.

There are a lot of factors that will disturb the aiming phase such as the stability of archers, concentration and the heart rate. The aiming stability described as the key factor that affected the archery performance (Shiang, 1997). Successful shooters also report that their total focus is on aiming when they shoot well, allowing the release to happen when the time is right rather than attempting to make it happen (Kathleen M, 1997). For the archers, all of the concentration must be devoted to aiming.

2.7.2 Heart Rate In Archery

With archery performance, heart rate variability is associated with the higher parasympathetic activity and a better balance of parasympathetic and sympathetic are beneficial to performance within the sport (Lo, 2008). Lower heart rate will result in better accuracy because if our heart rate beats faster it will affect our concentration on the aiming part. The experience of archers results in better accuracy and less heart rate, verifying that experienced archers statistical differ to inexperienced archers (Filipe Clemente, 2011). In the performance of an archer, no matter how confident, motivated, or technically or physically prepared athletes are performing, they will simply not be able to perform their best if their bodies are not at an optimal level of intensity, accompanied by the requisite physiological and psychological changes.

Several studies had been done to study the relationship between the effects of heart rate on archery performance. A case study on 18 male archers was conducted to analyze the heart rate and accuracy performance of experienced and inexperienced archer. Experienced archers demonstrate a better accuracy and at the same time a small amount of heart rate compared to inexperienced archers. It is possible that with the experience of the archers helps to develop the arousal control and, therefore, balance between sympathetic and parasympathetic systems (Lo, 2008). The highest heart rate may affect the performance of an archer. This is because it may distract the concentration of the athlete during the aiming phase if the athlete is too pressure and might think about other thing so that they cannot focus on the target. Experienced archers had a lower heart rate (87.20 bts min) compared to inexperienced archers (93.96 bts min). In addition experienced archers showed higher accuracy, obtaining a higher score (6.20 pts) compared to inexperienced archers (5.48 pts) (Table 2.2).

Table 2.2. Descriptive statistics of the experienced and inexperienced archers

		N	Mean	Std. Deviation
Heart Rate	Experienced	216	87.20	14.22
	Inexperienced	216	93.96	19.36
	Total	432	90.58	17.30
Score	Experienced	216	6.20	2.68
	Inexperienced	216	5.48	2.72
	Total	432	5.84	2.72

Source: Filipe Clemente, 2011

Arousal is the part of several emotional responses, together with anxiety and fear, and is characterized by feelings of apprehension, nervousness, and tension (Filipe Clemente, 2011). The heart rate has been considered as an important psychological factor of attention. Some level of sport related performance anxiety is considered to be normal and healthy, conversely, extreme anxiety in athletes can be disadvantageous in these performance situations (Dilip R. Patel, 2010).

2.7.3 Concentration In Archery

In archery, concentration also the main thing to have a better aiming part and have a better performance. Attention is divided into many parts. Among them, archery is associated with visual attention, mental attention, and selective attention. Visual attention and mental attention are involved in the normal shooting process (Lee, 2009). When an archer sets up the shooting process, he or she should be clear-minded and may only look at the tip of the arrow. Archery really is 95 percent mental and 5 percent physical, so when archers are at a tournament, not only should they be focused, but they should be calm. Archery requires a ton of concentration and it is extremely difficult due to the amount of stress your arm receives from the tension of the string and your mental stress due to all the focus you are putting into getting the arrow into the target. High

performance athletes have a strong mentality in addition to their pertinent skills and physiological capabilities (Behncke, 2004).

A good archer will not only have a good physical fitness and skill but they must also prepare with the psychological fitness. During the optimal zone, the athletes need to stay calm and focus on the target. Before releasing the arrow, the athletes should avoid the anxiety, focus on the target, give a full of concentration and must have full of confidence. In order to control the mind, the archers need to avoid thinking about a negative thing and have a positive self-talk to perform successfully on the sooting. This is called strong mentality which high performance athlete will have. This strong mentality is related with motivation, mental concentration on the game, stress and anxiety management, self-confidence, and emotion control (Young, 1999).

In addition to having proficient technique and excellent physical conditioning, athletes still need a high level of attention and optimal arousal level to obtain effective performance. In effective sports such as archery, attention has been considered as the most psychological factor dominating performance during the shooting. According to Lee (2009), archers have to concentrate only on the shooting process and should not lose concentration by external noise or internal thought distractions like anxiety.

Archers can be successful by establishing good form and repeating that good form on every shot. As with so many sports, though, often little separates archers in physical skills and equipment. A good mental approach takes on increasing importance. Strong mental skills help archers achieve success and long-lasting enjoyment of the sport. Good mental skills are no more accidental than good shooting skills. Both must be practiced (Kathleen M., 1997). It is easy to say that concentration is the key factor to good shooting. What is difficult is to know which aspects of putting a shot together with the attention.

2.8 HEART RATE AND CONCENTRATION IN PERFORMANCES

From the literature review, the heart rate and concentration plays an important role in having a good performance in sports. Not only in archery, but for all shooting sports like rifle shooting, pistol shooting and golf that require the aiming part to score, the athlete must have a stable heart rate and full of concentration to score. Despite of having good skills and physical strength, the athlete must know how to aim very well and focus on the target. Besides, the stability of the athletes is also involved in the good performance of the athletes. For experienced athletes, it will be the advantage for them because from the previous study the experienced of the athletes results in lower heart rate and better performance.

For the methodology part, the relationship between the heart rate and biofeedback system for the archery performance need to be determined. The number of subjects used in this study will be 10 archers from Majlis Sukan Negeri Terengganu (MSNT).

CHAPTER 3

PROJECT METHODOLOGY

3.1 INTRODUCTION

This chapter discusses about the method that will be used to analyze the aiming technique in archery shooting. The method used will be based on the project objectives, which analyze techniques from archery athlete, study the relationship between heart rate and emotions with the archery performance and to relate the aiming time with the shot point. This chapter will present the information on the subject, data collection instruments and methods, and details of control paradigms.

3.2 SUBJECTS

The subjects that will be present in this study are 10 archers from Majlis Sukan Negeri Terengganu (MSNT) that will do the archery shooting experiment. It consists of 5 from experienced archers and another 5 from less experienced archers. Experienced archers have 4 to 9 years experienced in archery while less experienced archers will be below 3 years of experienced. All archers must be confirmed to have a good health and not taking medication which known to affect the brain activity. Before starting the experiment, the subjects need to know the purpose of the experiment and how the experiment will be conducted.

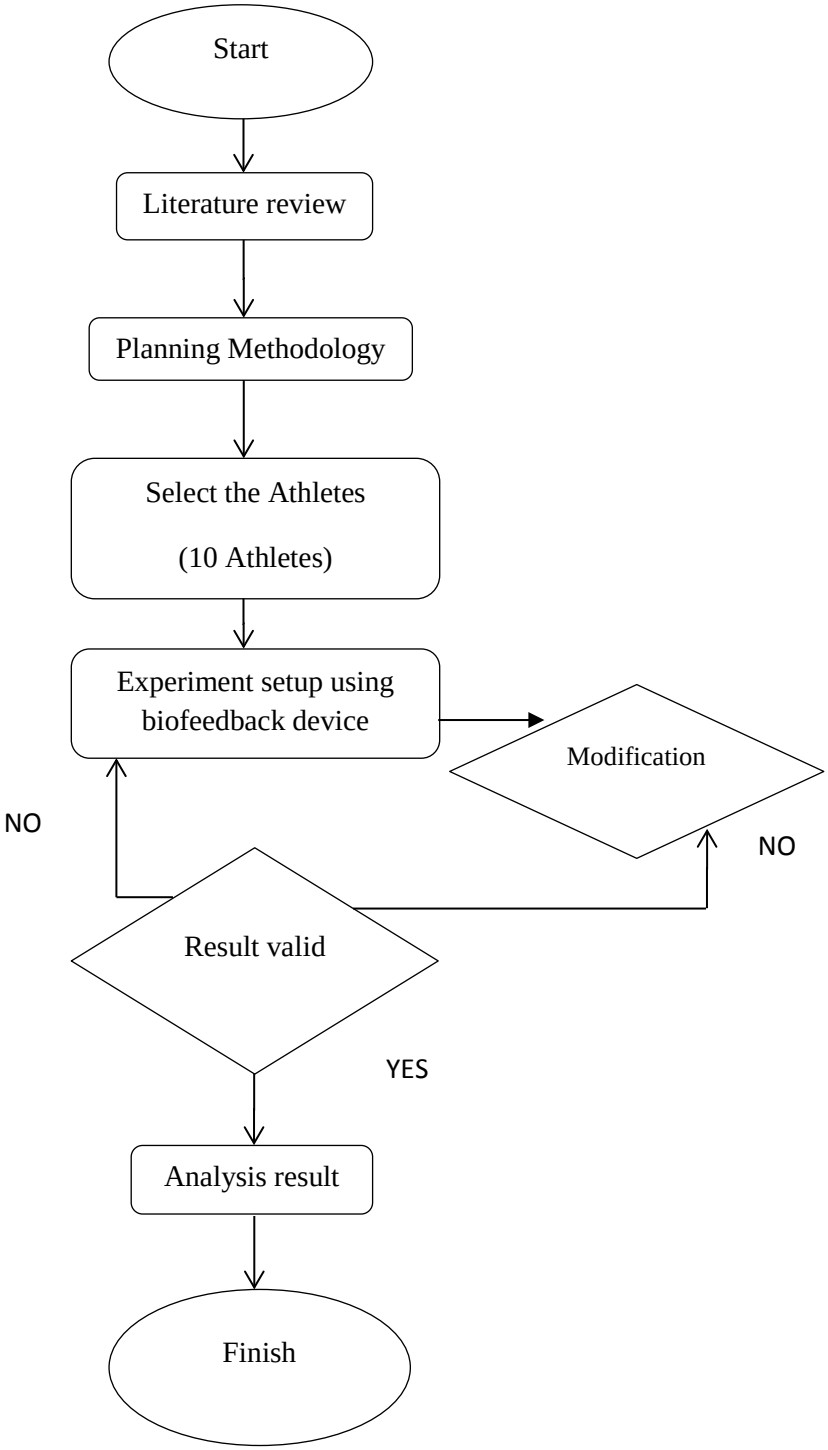

Figure 3.1: Flowchart overview for this study

3.3 FLOW CHART DESCRIPTION

The flowchart from Figure 3.1 describes the overall flow of this project. Each step in the flowchart will be discussed in the sub-topic.

3.3.1 Literature Review

From the review of the previous journal, there is some methodology that can be used to apply in this project. The review of literature is important for planning a methodology because previous journal had already success in their experiment so the method on how the experiment was conducted can be used to be applied.

3.3.2 Planning Methodology

The methodology that has been done is based on the previous journal in the literature review. 10 archers are chosen for the experiment which consists of 5 archers from experienced and 5 from less experienced archers. All archers were chosen from this 2 category because in order to make a good analysis and the comparison of the heart rate and concentration of the archer can be clearly seen from the graph of the analysis.

3.3.3 Experimental Setup

This project will use one main device to detect the heart rate and concentration of the archer which is the biofeedback device. The biofeedback sensor will be put at the top of the finger. After getting all the data from the athletes, the results will be analyzed. The distance for this archery experiment is 30 meter.

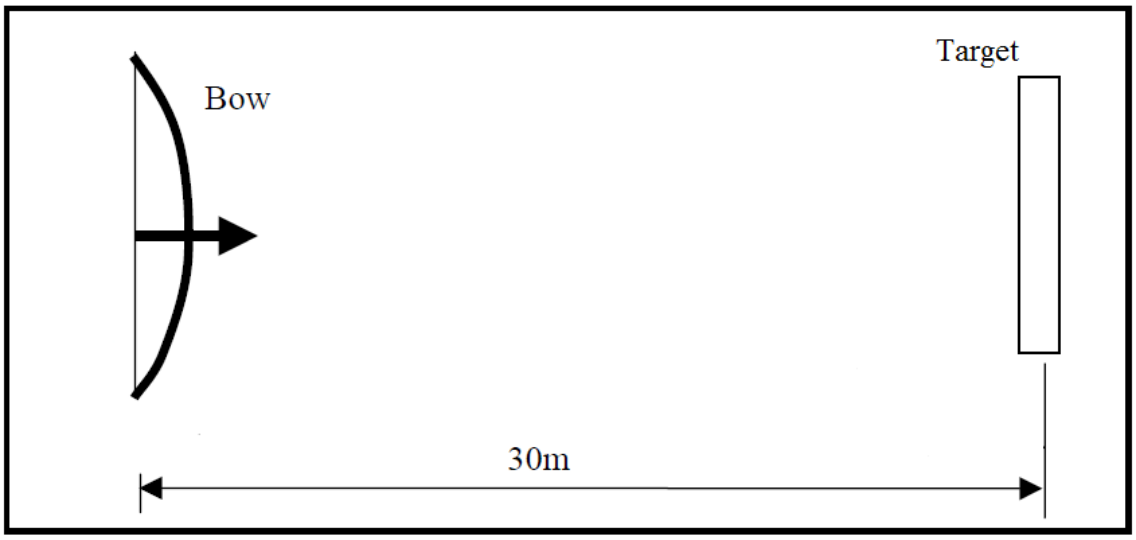

Figure 3.2: Experimental Setup

Figure 3.3: Experimental Setup On Athlete

3.4 EQUIPMENTS

The equipment that will be used in this project will help to get the data from the archery athletes. The equipment used will be attached to the archer's body for the data collection. For this project, as stated in the objective, the biofeedback device will be used for recording the heart rate and showing the concentration of the athlete. The biofeedback device will be the main equipment that will be used because this device is important to take data which relate with the objectives.

3.4.1 Biofeedback device

General biofeedback is a tool to provide human beings with enhanced awareness of their mind-body lineage, increased control over their physiology, and increased access to self-regulation strategies (Donald Moss, 2012). The biofeedback would awaken human creativity and enable human beings to reach higher states of consciousness. The biofeedback device will help to show the concentration of an archer. From this device, it will show the data on the frequency level of the athlete. The data consists of 3 stages of frequency level which is the very low frequency (VLF), low frequency (LF), and the high frequency (HF). Therefore, from this frequency, the VLF will show the stress of an archer, LF will show the concentration and HF will show the relax state of an archer. When the value of LF is higher, the more concentrate the athlete on the target.

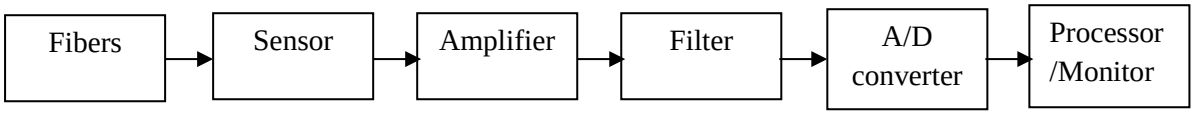

Figure 3.4: Processing sequence

For this device, it will take the data on blood volume pulse (BVP) of the archer. Figure 3.4 shows the processing sequence for the BVP sensor. The BVP sensor shines infrared light through the finger and measures the amount of light reflected by the skin. The amount of reflected light varies during each heart beat as more or less blood rushes through the capillaries. The sensor converts the reflected light into an electrical signal

that is then sent to the computer to be processed. From Figure 3.5, the BVP sensor does not require skin preparation as it is placed directly in contact with the skin. Place the sensor against the fleshy part of the first joint of any finger and hold it in position using the elastic strap.

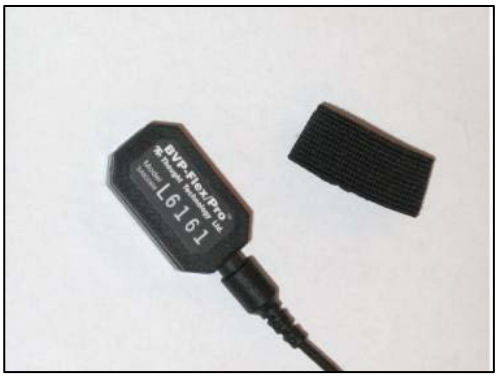

Figure 3.5: The BVP sensor

The BVP sensor is sensitive to light, movement and pressure. To prevent artifacts caused by light interference, be careful to adjust the two small openings on the sensor's front so they are firmly pressed against the finger pad and there is no gap between the black edges of the sensor and the skin. If the archer’s fingers are too small, it is recommended to place the sensor on the thumb pad. Pressing the sensor too firmly against the finger pad will decrease the sensitivity of the signal because excessive pressure reduces blood circulation in the fingertip. Look at the raw signal when adjusting the sensor against the finger pad and try to maximize the signal amplitude.

Figure 3.6: A/D converter (ProComp 2)

From Figure 3.6, this device is analog to digital (A/D) converters that are called encoders. ProComp 2 has 2 channels (A and B) sampling at 256 samples per second and 2 channels (C and D) sampling at 32 samples per second. Because channel A contains an integrated EEG sensor, it cannot be used to measure other types of physiological data. Only two channels at a time can be used to record data, either A and B, or C and D. This device will be connected with the BVP sensor to get the data.

3.4.2 Other equipment

Other equipment that will be used in this project are the digital video camera, and the archery set that consists of the bow, arrow and the target board. The digital video camera will be used to capture the shot points.

3.5 PROCEDURE

10 archers will be selected to do the experiment. It involves archers from experienced and less experienced archers. At first, the biofeedback device which is the BVP sensor will be put at the finger of the archers to get the emotions level and the heart rate of the archers. One digital video camera will be used to take the shot points from the target board. After done setup all the equipment, the archer need to relax and sitting on chair for one minute. This process is for taking the biofeedback data which need the archers to relax and calm before start the experiment. After one minute, the archers can start releasing the arrow to the target. There will be 18 shots per archer. The six shot will be done for aiming in 3 seconds, next will be in 5 seconds and for the rest will be done in 7 seconds. After doing all shots, the readings from the biofeedback device will be taken. The results of the shot points will be view from the camera. For the biofeedback analysis, the BioGraph Infiniti Physiology Suite software will be used to record and analyze the data. The flowchart from figure 3.7 describes the procedure for taking data from the biofeedback devices.

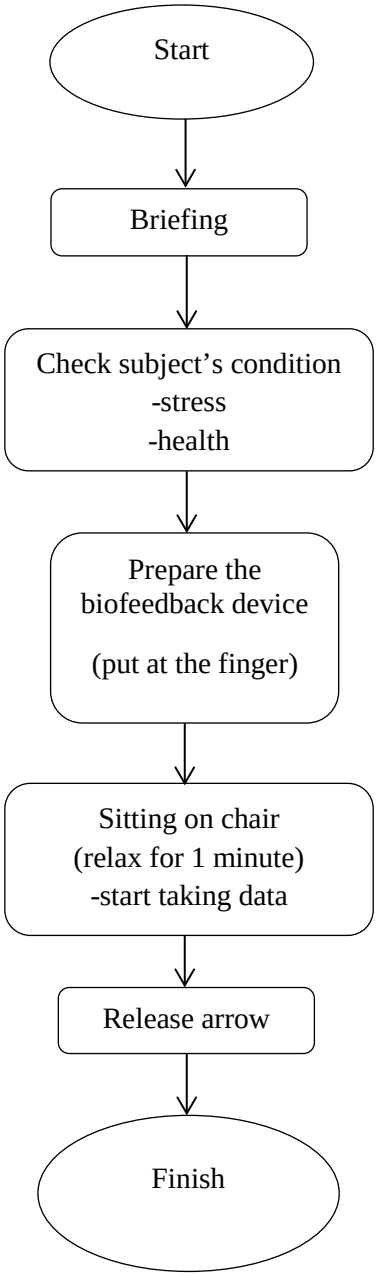

Figure 3.7: Flowchart overview for the biofeedback procedure

3.6 STATISTICAL ANALYSIS

The statistical analysis need to be done in order to analyze the data of the experiment. From the experiment, the data of heart rate, score from different aiming time and the data of stress, concentration and relax level of the athletes need to be analyze with the statistical analysis in order to find out whether the data is significant or not. There are many ways to do the statistical analysis. For this experiment, the statistical analysis that been used is the t-independent test, regression analysis and the analysis of variance (ANOVA).

3.6.1 Descriptive Statistics

Descriptive statistics consists of the collection, organization, classification, summarization, and presentation of data obtain from the sample. It is used to describe the characteristics of the sample and to determine whether the sample represent the target population by comparing sample statistic and population parameter. From the descriptive statistics, set of data can be summarized using measures of central tendency, such as the mean, median, and mode. Besides, it also can describe data using measures of variation, such as the range, variance, and standard deviation. For this experiment, mean and standard deviation will be find out for the descriptive statistics. Mean is the sum of the values divided by the total number of values while standard deviation is the square root of the variance.

Sample mean,

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad , \; n \text{ sample size} \qquad \text{(Eq. 3.1)}$$

Standard deviation,

$$s = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \overline{x}\right)^2}{n-1}}, \quad n \text{ sample size} \qquad \text{(Eq. 3.2)}$$

3.6.2 Test Hypothesis for Paired Data

The hypothesis test was used to analyze the difference between means when samples were independent. The hypothesis test concern on the samples taken from the population. The samples are considered to be dependent samples whereby they can be paired. Besides, it can also be applied to two populations provided that they are homogeneous which is having the same characteristics and criteria, and both populations must be approximately normally distributed. From the t-independent test, it will shows whether the data is significantly difference or not from the t-statistic and the p-value. The p-value must be less than 0.05 to be significant.

$$t_{test} = \frac{\bar{x}_D - \mu_D}{S_D/\sqrt{n}} \quad \text{(Eq. 3.3)}$$

Where, D = $X_1 - X_2$

$$\bar{x}_D = \frac{\sum_{i=1}^{n} x_{D_1}}{n} \quad \text{(Eq. 3.4)}$$

x_{D_1} is the differences between the paired data, and *n* is the number of pairs

$$S_D = \sqrt{\frac{n\sum_{i=1}^{n} x_{D_1} - \left(\sum_{i=1}^{n} x_{D_1}\right)^2}{n(n-1)}} \quad \text{(Eq. 3.5)}$$

3.6.3 Analysis of Variance (ANOVA)

ANOVA is the approach that allows us to use sample data to see if the values of three or more unknown population means are likely to be different. It is also known as factorial experiments. For this experiment, two-way ANOVA technique will be used to determine if there is an effect of interaction between two factors experiment.

3.6.4 Null & Alternative Hypothesis

Interaction effect

H0: there is no interaction effect between factor A and factor B.

H1: there is an interaction effect between factor A and factor B.

Row effect

H0: there is no difference in means of factor A.

H1: there is a difference in means of factor A.

or

H0: there is no effect from factor A.

H1: there is effect from factor A.

Column effect

H0: there is no difference in means of factor B.

H1: there is a difference in means of factor B.

or

H0: there is no effect from factor B.

H1: there is effect from factor B.

H0 will be rejected if the p-value of the interaction effect is less than 0.05 and H1 will be accepted.
H1 will be rejected if the p-value of the interaction effect is more than 0.05 and H0 will be accepted.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

This chapter 4 discuss about the results and factors that will helps to enhance the performance of archery. The objective of this chapter is to determine the relationship between heart rate and emotions from biofeedback device with archery performance. Besides, this chapter also will determine which one is the best aiming time from the relationship between the aiming time and the shot points.

The parameters to be observed in this study are the heart rate of an archer and the emotions level from the biofeedback device which shows the level of stress, concentration and relax state of an archer. While the constant parameters are the aiming time that are set to be 3, 5 and 7 seconds. This analysis will be focusing on the relationship from the parameters observed with the shot points in order to determine the performances.

4.2 RELATIONSHIP BETWEEN HEART RATE AND PERFORMANCES

The analysis of heart rate with the shot points is done by using the statistical analysis for the data from experienced and less experienced archer. The data is divide into this 2 category in order to find out which archer will have the lowest heart rate and get the highest score because from that we can determined does the heart rate will affect the performance of an archer or not. The t-independent test was used to establish the statistically significant differences between experienced and less experienced archers. The analysis was performed using the Portable Origin Pro software (version 8.5.1).

The experimental results shows that experienced archers had a lower heart rate, 96.25 beats per minute (bpm) compared to less experienced archers, 97.87 bpm. Besides, experienced archer obtained higher accuracy compared to less experienced archers. For experienced archer, the higher score obtained is 8.60 points, while less experienced archers is 7.93 points.

Table 4.1. Descriptive statistics of the experienced and less experienced archers

		N	Mean	Std. Deviation
Heart Rate	Experienced	90	96.25	7.44
	Less Experienced	90	97.87	6.39
	Total	180	97.06	6.96
Score	Experienced	90	8.60	1.31
	Less Experienced	90	7.93	1.40
	Total	180	8.27	1.39

Table 4.2. Significant values of the experienced and less experienced archers

	t	Sig. (p-value)	Mean Difference
Heart Rate	-2.942	0.042	-1.62
Score	2.863	0.013	0.67

Form table 4.2, the t-independent test showed significant statistical differences between experienced and less experienced archer. From the analysis, the experienced archers have more and better score compared to less experienced archers.

Table 4.3. Correlation values between heart rate and score of archery performance

Archer	Correlation coefficient (r)
Experienced	- 0.048
Less Experienced	- 0.056

Table 4.3 shows the correlation values between heart rate and score of archery performances from experienced and less experienced archers. The correlation value for experienced archer is – 0.048 while for less experienced archer is – 0.056. Although the value is a negatively weak correlation, it shows an inverse relationship between the heart rate and score. The negative correlation indicates that the increase in heart rate will results in the decrease of score as well as the reverse.

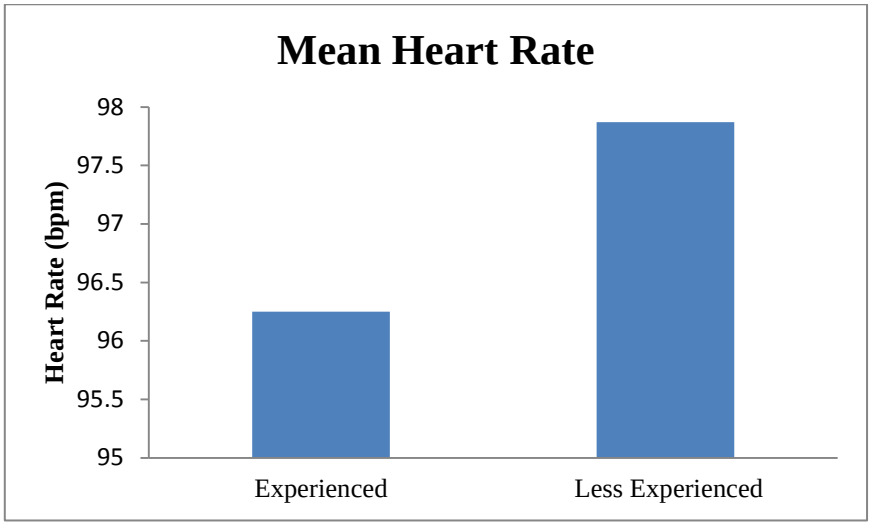

Figure 4.1: Mean heart rate for experienced and less experienced archers

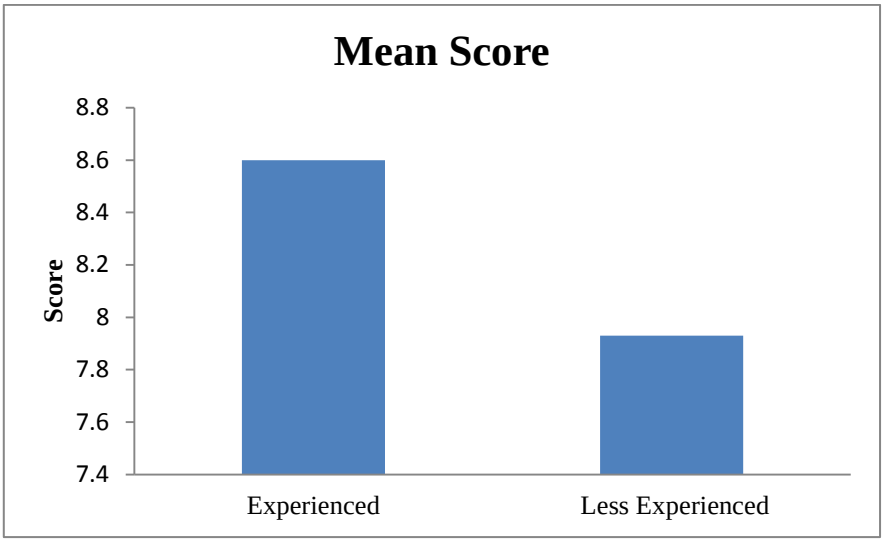

Figure 4.2: Mean score for experienced and less experienced archers

Figure 4.1 and 4.2 shows the mean heart rate and mean score graph for experienced and less experienced archers. From the graph, it is clearly showed that experienced archers have a low heart rate compared to less experienced archer and experienced archers also have a higher score. This proved that experienced archers can score well compared to less experienced archers with a lower heart rate.

4.2.1 Discussion Based on the Analysis of Heart Rate

One of the objectives of this study is to find out the relationship between the heart rate and the performance of an athlete. Referring to data of analysis, it showed the relationship between the heart rate and performance of an athlete based on score results. From the data, the t-independent test indicates significant statistical differences between experienced and less experienced archer. The correlation value between the heart rate and the score are low and showed a negatively weak correlation but from the correlation it also shows an inverse relationship between the two parameters. In sports that require an aiming part for scoring like archery, the athletes must be more relax and calm in order to focus and have a better accuracy. Low levels of arousal and a balance between sympathetic and parasympathetic stimulation is needed for sports accuracy (Filipe Clemente, 2011).

Experienced archers show a better accuracy with a lower heart rate compared to less experienced archers. This proved that the lower heart rate can affect the performance of an athlete. Experienced archers had a lower heart rate due to their experienced in the sports and it helps to be calm and more relax during the tournament.

4.3 ANALYSIS OF AIMING TIME WITH SHOT POINTS

There are three 3 values in this parameters that has been set to be fixed which is 3, 5 and 7 seconds that will be used for the aiming time. This aiming time is set to be fixed in order to find out the relationship between the aiming time and the performance of an athlete. From the data analysis, the best aiming time can be determined and it can show does the shorter or longer aiming time will affect the performance of athlete. The aiming time was set 3, 5 and 7 seconds because for target archery, full concentration is only critical for about 10 seconds at a time during each shot. For this experiment, the archers need to shot 6 trials for 3, 5 and 7 seconds. Total shots for this experiment will be 18 shots per athlete. From this shot, the best aiming time can be determined from the score at each aiming time.

Table 4.4. Correlation values between aiming time and score of archery performance

Archer	Correlation coefficient (r)
Experienced	0.115
Less Experienced	0.167

Table 4.4 shows the correlation values between aiming time that is set to be 3, 5 and 7 seconds with score of archery performances from experienced and less experienced archers. The correlation value for experienced archer is 0.115 while for less experienced archer is 0.167. This showed that there is a weak correlation between the aiming time and the score of experienced and less experienced archers.

Table 4.5. Interaction effect between aiming time and score using Anova

Archer	p-value
Experienced	0.033
Less Experienced	0.016

From table 4.5, the p-value for experienced archer is 0.033 and for less experienced archer is 0.016. Since the p-value is less than 0.05, so there is an interaction effect between the aiming time and the score for the experienced and less experienced archers.

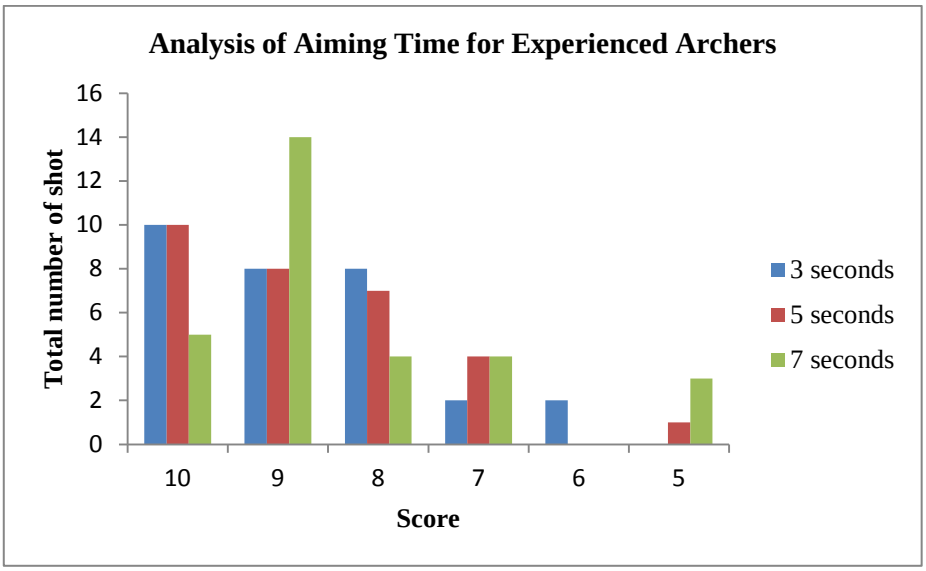

Figure 4.3: Analysis of aiming time with score for experienced archers

From figure 4.3, it showed the score obtained from 3, 5 and 7 seconds for experienced archers. As a result, during aiming in 3 and 5 seconds, the total number of shots for score of 10 is same which is 10 shots. For score of 9, the total number of shots for aiming time in 3 and 5 seconds also same which is 8 shots. From the graph, aiming time in 7 seconds is the worst for the experienced archers because it is hard to score 10 points and there were 3 shots that hit the lowest score during this aiming time.

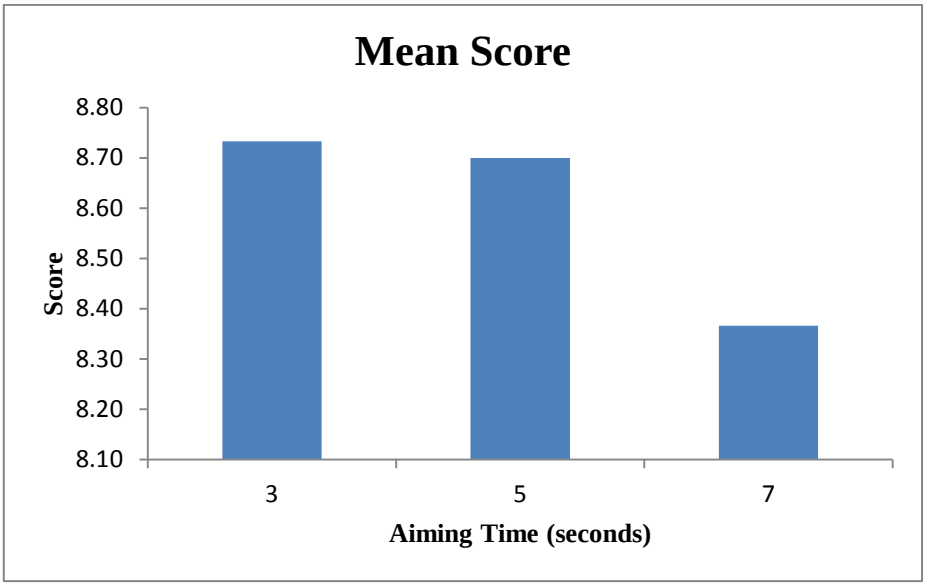

Figure 4.4: Mean score with different aiming time for experienced archers

Figure 4.4 showed the mean score with different aiming time for experienced archers. From the graph, the highest mean score is during aiming time in 3 seconds while the lowest mean score is during the aiming time in 7 seconds. During 3 seconds, the mean score is 8.73 points while during 5 and 7 seconds the mean score is 8.70 points and 8.37 points. But, there is only a little different between the mean score during aiming time in 3 and 5 seconds.

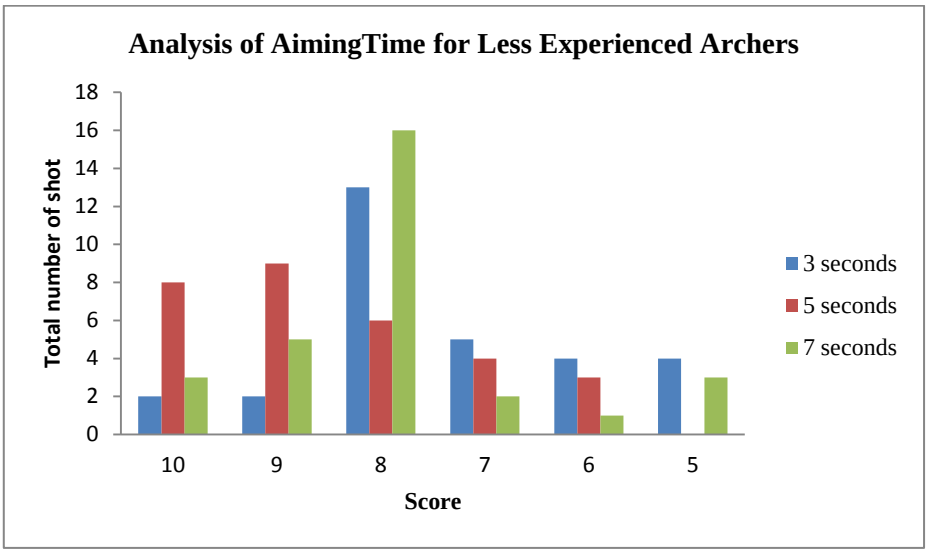

Figure 4.5: Analysis of aiming time with score for less experienced archers

From figure 4.5, it showed the score obtained from 3, 5 and 7 seconds for less experienced archers. During aiming time in 5 seconds, less experienced archers can score well for the 9 and 10 points compared to aiming time in 3 and 7 seconds. Total number of shots for score of 10 was 8 shots while for score of 9 was 9 shots during aiming time in 5 seconds. From the graph, aiming time in 3 seconds is the worst for the less experienced archers because there were only 2 shots hit the score of 10 and there were 4 shots hit the lowest score during this aiming time.

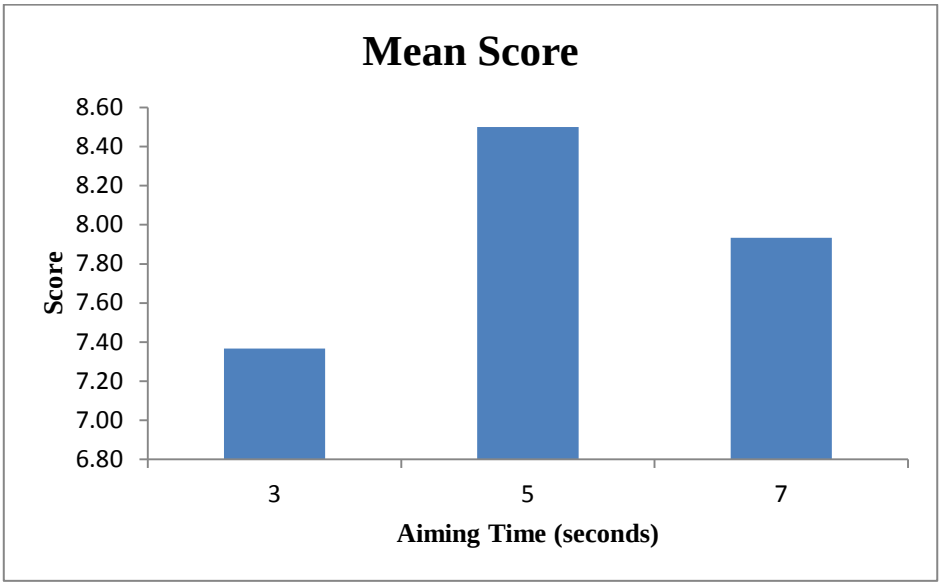

Figure 4.6: Analysis of aiming time with score for less experienced archers

Figure 4.6 showed the mean score with different aiming time for less experienced archers. From the graph, the highest mean score is during aiming time in 5 seconds while the lowest mean score is during the aiming time in 3 seconds. During aiming time in 3 seconds, the mean score is 7.37 points while during 5 and 7 seconds the mean score is 8.50 points and 7.93 points.

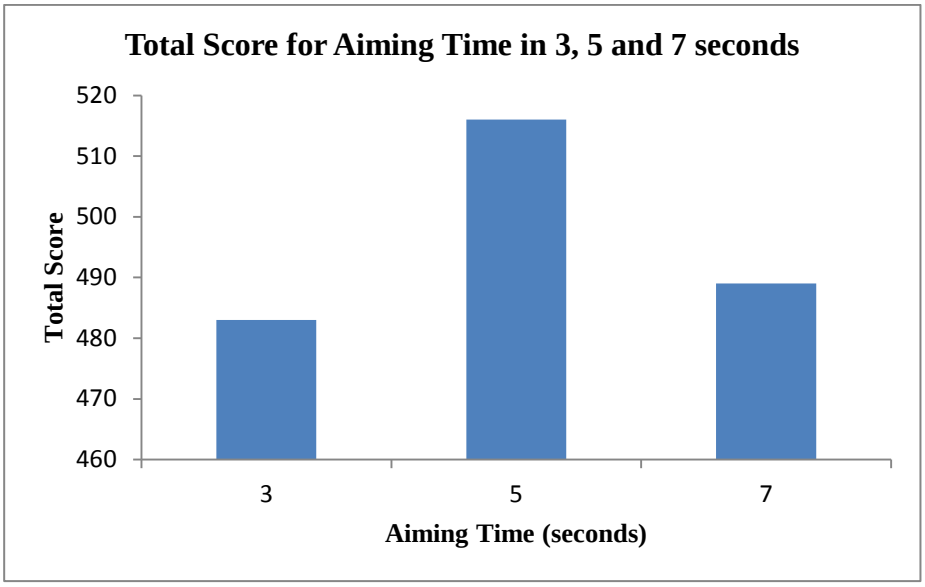

Figure 4.7: Total score for aiming time in 3, 5 and 7 seconds

Figure 4.7 shows the total score obtained from experienced and less experienced archers during the aiming time in 3, 5 and 7 seconds. During 3 seconds, the total score for the archers is 483 points, while in 5 seconds the total score is 516 points and during 7 seconds the total score is 489 points.

4.3.1 Discussion Based on the Aiming Time with Shot Points

The aim of this study is to find out the relationship between the aiming time with the shot points. From the three aiming time, which one is the best and can have a good score. Based on the data analysis, the best aiming time is during 5 seconds because at this time, all level of archers can score well and have a good points compared to the results during the aiming time in 3 and 7 seconds. Besides, from the total score of the shot points, during 5 seconds the archers can score 516 points which is the highest score between the three aiming time.

The time interval during the aiming phase is very important for the archers in order to focus and aim at the target. During this time, if the archer takes so much time for aiming it might disturb the concentration and affect the stability of the archers. The archers might produce a lot of vibration while pulling the string of the bow during

aiming phase if the archers take a longer time for aiming. Furthermore, the aiming time also cannot be too fast for long distance target archery because the archers might be not ready and cannot concentrate and focus perfectly on the target board if the aiming time is too short.

From the analysis, experienced archers can score well during the aiming time in 3 and 5 seconds. This showed that experienced archers only need a short aiming time during the aiming phase. Besides, from the results, during aiming time in 7 seconds, the score results were the worst for the experienced archers. The longer aiming time might distract the concentration and the balance of the archers.

The results for less experienced archers during aiming time in 3 seconds was not good compared to aiming time in 5 and 7 seconds. For less experienced archers, a short aiming time is not enough and it is hard to focus and aim during that aiming time. This is because less experienced archers still need time to learn and practice for the aiming part. The most suitable and best aiming time for less experienced archers is 5 seconds.

4.4 RELATIONSHIP BETWEEN STRESS, CONCENTRATION AND RELAX LEVEL WITH PERFORMANCES

One of the aims of this study is to find out the relationship between emotions from the biofeedback device with the performances. The biofeedback system included the physical emotion of an athlete during the tournament. For instance, the stress level of an athlete, the concentration during the tournament and the relax state of an athlete. It is important to know whether this kind of emotion can give a big impact to an athlete or not and how much this factor can affect the performance of an athlete. For target sport like archery, the concentration is very important in order to have a good score. The athlete need to focus and concentrate during the aiming phase and need to avoid stress. But, sometimes this sport also may happen by chance, which is depends on their luck and only a little skill involve. Their emotion can be a factor for a good or bad result, but how much does the emotion can give an impact to a performances.

From the biofeedback device, it comes out with three data which is the very lower frequency (VLF), lower frequency (LF), and higher frequency (HF). The VLF will represent the stress level of the athlete, the LF is the concentration of the athlete while the HF is their relax level. From this data, it will be correlate with the score obtain by the athlete in order to know how far this factors can affect the performances of the athlete. For the statistical analysis, test of linear regression and t-independent test was applied to find out the correlation between the data and the analysis was performed using the Portable Origin Pro software (version 8.5.1).

Table 4.6. Correlation values between emotions and score of archery performance for experienced archers

	Correlation (r)	p-value
Stress (VLF)	0.385	0.036
Concentration (LF)	0.052	0.786
Relax (HF)	0.263	0.160

From table 4.6, the correlation values between stress (VLF) and score is 0.385 and the p-value is 0.036. For concentration (LF) and relax (HF), the correlation value is 0.052 and 0.263 while the p-value is 0.786 and 0.160. The analysis indicates that there is a weak correlation between the emotions and score of experienced archers and only the data of stress (VLF) level is significant due to the p-value that is less than 0.05.

Table 4.7. Correlation values between emotions and score of archery performance for less experienced archers

	Correlation (r)	p-value
Stress (VLF)	0.377	0.040
Concentration (LF)	0.081	0.670
Relax (HF)	0.242	0.198

Table 4.7 showed the correlation values between stress (VLF) and score is 0.377 and the p-value is 0.040. For concentration (LF) and relax (HF), the correlation value is 0.081 and 0.242 while the p-value is 0.670 and 0.198. The analysis indicates that there is also a weak correlation between the emotions and score of less experienced archers and only the data of stress (VLF) level is significant.

Table 4.8. Descriptive statistics of the experienced and less experienced archers

			N	Mean	Std. Deviation
Experienced	Stress	(VLF)	90	15.24	7.15
	Concentration	(LF)	90	36.23	10.06
	Relax	(HF)	90	48.43	10.80
	Score		90	8.60	1.31
Less Experienced	Stress	(VLF)	90	16.24	7.92
	Concentration	(LF)	90	36.08	8.56
	Relax	(HF)	90	47.68	10.25
	Score		90	7.93	1.40

Table 4.9. Significant values of the experienced and less experienced archers

		t	Sig. (p-value)	Mean Difference
Stress	(VLF)	-2.488	0.019	-1.00
Concentration	(LF)	1.561	0.129	0.15
Relax	(HF)	0.322	0.322	0.75

Form table 4.9, the t-independent test showed significant statistical differences for the stress (VLF) level between experienced and less experienced archer. From the analysis, the experienced archers showed low stress level and better score compared to less experienced archers.

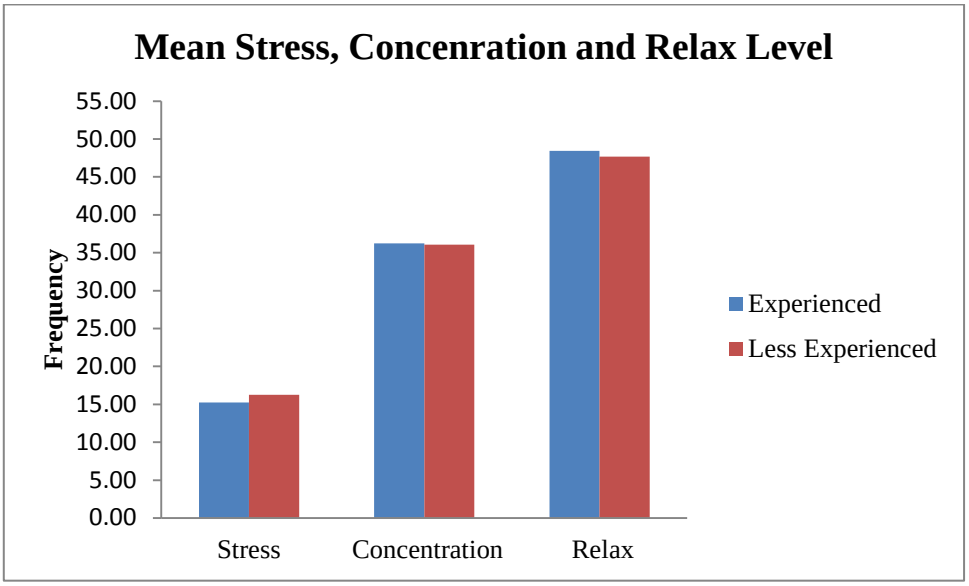

Figure 4.8: Mean stress, concentration and relax level between experienced and less experienced archers

From figure 4.8, it showed mean for the level of stress, concentration and relax between experienced and less experienced archers. From the graph, the concentration level between experienced and less experienced archers is almost the same. But, for the stress and relax level, it shows a different between the experienced and less experienced archers. For experienced archers, the stress level is low compared to less experienced archers. For the relax level, experienced archers showed more relax compared to less experienced archers. The mean score obtained from experienced archers is 8.60 points while for less experienced archers is only 7.93 points. From the analysis, it is proved that emotions will have an affects to the performance of an athlete especially the stress and relax level of the athletes.

4.4.1 Discussion Based on the Analysis of Emotions with Performances

From the data analysis, there is a weak correlation between the data of VLF, LF and HF with score. Although the correlation value is low, the data still can affect the score of the shot points but the percentage is very low. From the correlation, the stress level for experienced and less experienced archers showed a higher correlation compared to concentration and relax level. From the t-independent test, there were significant statistical differences between the data of the emotions with score. Besides, from the analysis, the p-value for the stress level is significant because it was less than 0.05. Based on the results, the concentration between experienced and less experienced archers was almost the same but there was a difference between the stress and relax level of the athletes. Less experienced archers showed a higher level of stress and low level of relax compared to experienced archers. For the performance, experienced archers can score well and obtain a higher score compared to less experienced archers.

In archery, concentration can be the most important factor to achieve a good score. But, other factors also can affect the performance of an athlete and the concentration might be the minor factor in this sports. Sometimes the athlete with a good skills and experienced did not fully depends on their concentration because the emotion is just a feeling that can give confidents and helps to focus in a better way. If the athletes have a good concentration, other factors like stress level might distract the concentration and affects the performance of the athletes. It is important for the athletes to keep calm and control the stress level especially during the tournament. Usually, experienced archers can control their stress well compared to less experienced archers.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The main objective of this study is to find out the best aiming technique in archery shooting. In order to achieve this objective, analysis on the aiming technique from experienced and less experienced archers was done in order to improve the archery sports. Other objectives of these projects are to find out the relationship between the heart rate and the emotions with the performances of the athletes. The comparison of heart rate between different levels of archers proved that lower heart rate will contributed to a higher score. This was shown by the experienced archers that have a lower heart rate and can have a good score compared to less experienced archers that have a higher heart rate and lower score. For the emotion which is included the stress, concentration and relax level of the athletes, the analysis showed that the stress and relax level of the athletes can affect the performances. It is almost the same for the concentration between experienced and less experienced archers. But, less experienced archers showed a higher level of stress and lower level of relax compared to experienced archers. The last objective of this study is to find out the best aiming time for archery sports. From 3 aiming time that are set to be 3, 5 and 7 seconds, the best aiming time for long distance archery sports is 5 seconds. This is because during this aiming time, the archers can perform well and can get a higher score.

5.2 RECOMMENDATIONS

From the data analysis, there was a weak correlation between the data of heart rate and emotions with the performances of the athletes. The weak correlation is might be due to a several factors. For instance, the procedure for taking the data is very important in order to get a good result from the device. This is because the biofeedback device is very sensitive in order to capture the value of the emotions level of the athletes. Besides, for the future research, try to change the biofeedback device with other device which is more comfortable for the athletes. This is because most of the athletes did not comfortable when putting the biofeedback sensor at the top of their finger because it will distract the athlete while releasing the arrow and it will affect the performance of the athletes.

REFERENCES

Behncke, L. (2004). *Mental Skills Training for Sports: A Brief Review*. Athletic Insight.

David L. Neumann, P. R. (2009). The Relationship Between Skill Level And Patterns In Cardiac And Respiratory Activity. *International Journal of Psychophysiology*.

Dilip R. Patel, M. H. (2010). *Sport-related Performance Anxiety in Young Female Athletes.*

Donald Moss, S. V. (2012). *The Use of General Biofeedback in the Pursuit of Optimal Performance.*

Ertan H, S. K. (2005). *Quantification the Relationship Between FITA Scores And EMG Skill Indexes In Archery*.

Filipe Clemente, M. C. (2011). Study of the Heart Rate and Accuracy Performance of Archers. *Journal of Physical Education and Sport*.

Hwang, K.-b. L.-k. (2004). Analysis of Correlation Between Aiming Procedure And Shot Points. *Annual Journal of Physical Education and Sports Science*.

Kathleen M. Haywood, C. F. (1997). *Archery: Steps to Success.*

Langenberg, R. R. (2002). *Aiming at a far target under different viewing conditions: Visual control in basketball jump shooting.*

Lee, K. H. (2009). *Evaluation of Attention and Relaxation Levels of Archers in Shooting Process.*

Leroyer P, V. H. (1993). *Biomechanical study of the final push-pull in archery.*

Lo, C.-T. H.-H.-M. (2008). *A Study of the Relationship Between Heart Rate Variability and Archery Performance.*

M. Doppelmayr, T. F. (2008). *Frontal Midline Theta In The Pre-Shot Phase of Rifle Shooting: Differences Between Experts and Novices.*

Mononen, K. K. (2007). Relationships between postural balance, rifle stability and shooting accuracy among novice rifle shooters. *Scandinavian Journal of Medicine and Science in Sports*.

Olaf Binsch, R. R. (2009). Unwanted Effects In Aiming Actions: The Relationship Between Gaze Behavior And Performance In A Golf Putting Task. *Psychology of Sport and Exercise*.

Patsy Tremaynea, R. J. (2000). Elite Pistol Shooters: Physiological Patterning of Best vs. Worst Shots. *International Journal of Psychophysiology*.

Ravindra S. Goonetilleke, E. R. (2009). Pistol shooting accuracy as dependent on experience, eyes being opened and available viewing time. *Applied Ergonomics*.

Shana K. Carpenter, K. R. (2012). External Focus of Attention Improves Performance In a Speeded Aiming Task. *Journal of Applied Research in Memory and Cognition*.

Shiang, T. Y. (1997). *A New Quantitative Approach For Archery Stability Analysis.*

Simo Ihalainen, S. K. (2012). *Effects of Aiming And Balance On Shooting Performance In International And National Level Air Rifle Shooters.*

Young, A. a. (1999). *The Zone: Evidence of a universal phenomenon for athletes across sports, Athletic Insight.*

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LIST OF ABBREVIATIONS

Bpm	Beats per minute
BVP	Blood Volume Pulse
FITA	The Federation Internationale de Tir a Arc
HF	Higher Frequency
LF	Lower Frequency
MSNT	Majlis Sukan Negeri Terengganu
Pts	Points
UMP	University Malaysia Pahang
VLF	Very Lower Frequency