ANALYSIS OF DIFFERENTIAL EFFICACY OF NEUROFEEDBACK AND BIOFEEDBACK INTERVENTION ON SOCCER PERFORMANCE

by

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CERTIFICATE

This is to certify that the dissertation entitled

ANALYSIS OF DIFFERENTIAL EFFICACY OF NEUROFEEDBACK AND BIOFEEDBACK INTERVENTION ON SOCCER PERFORMANCE

Is the bona fide record of research work done by

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Under my supervision

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CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

STAI	State – Trait Anxiety Inventory
EMG	Electromyograph
HR	Heart Rate
FIFA	Fédération Internationale de Football Association
GSR	Galvanic Skin Response
EEG	Electroencephalogram
SEMG	Surface Electromyograph
ACL	Anterior Cruciate Ligament
ES	Electrical Stimulation
MVPA	Moderate-to-vigorous intense activity
HRV	Heart Rate Variability
BFB	Biofeedback
SR	Skin Resistance
RT	Reaction Time
SA	State-Anxety
TA	Trait-Anxiety
CNS	Central Nervous System
ANS	Autonomic Nervous System
Sc	Skin Conductance
PGR	Psychogalvanic Reflect
SF	Spontaneous Fluctuation
EE	Energy Expenditure

ABSTRACT

The present study was undertaken with an objective to determine differential efficacy of psychotherapeutic interventions, namely Electromyographic (EMG) Biofeedback and Heart Rate (HR) Biofeedback in enhancing soccer skill ability in young male soccer players. Thirty six male soccer players from Universiti Sains Malaysia in the age ranging from 18 to 24 years volunteered as participants, who were assessed with psychological measure, such as, State-Trait Anxiety Inventory (STAI); psychomotor parameter, such as, Reaction Time (RT), Mirror Drawing, Two Arm Co-ordination, Neuromuscular Steadiness; and psychophysiological variables, such as, Galvanic Skin Resistance (GSR), Heart Rate and Electromyoghaphy (EMG). Theses assessments were done for the screening test and pre-intervention base line information. Thereafter they were randomly and equally categorized into three groups, i.e., each group consisted of 12 participants; viz. – Group A- control group; Group B – participants received training of EMG biofeedback and Group C – those who received HR Biofeedback training. Group wise respective intervention trainings (EMG & HR biofeedback) were imparted for 12 sessions (20 min.s /day; 2 days/ week for 6 weeks). Participants of Group A didn't receive any intervention training. Mid-term analyses on all of the variables assessed in the pre-intervention phase were done on all of the participants after the completion of three weeks of intervention. Thereafter the similar protocol of intervention was followed for three more weeks. Thereafter all of the participants were assessed once again for the post-intervention analyses (following similar analyses protocols). Findings of the analyses suggested that both EMG and HR biofeedback intervention had beneficial impacts onto coordination and psychomotor abilities of the soccer players. Furthermore, both of the interventions have been observed to result in alteration in the psychobiological make-up of the participants, which together with the enhanced coordination and psychomotor abilities finally resulted in improvements in soccer shooting and agility skills performance.

ABSTRAK

Kajian ini dijalankan bertujuan untuk mengenal pasti perbezaan keberkesanan antara intervensi maklum balas neuro dengan maklum balas bio, iaitu 'Electromyographic (EMG) Biofeedback' dan 'Heart Rate (HR) Biofeedback' dalam meningkatkan prestasi dalam kemahiran bola sepak terhadap pemain bola sepak lelaki muda. Tiga puluh enam (n = 36) pemain bola sepak yang muda serta dewasa, juga merupakan pelajar-pelajar Universiti Sains Malaysia yang berumur dalam lingkungan 18 – 24 tahun telah dipilih sebagai peserta kajian ini dan dinilai dengan ukuran psikologi seperti 'State and Trait Anxiety Inventory' (STAI) oleh Spielberger; parameter psikomotor seperti 'Reaction Time' (RT), 'Mirror Drawing', Two Arm Coordination', Neuromuscular Steadiness'; dan juga pembolehubah psikofisiologi seperti 'Galvanic Skin Response' (GSR), 'Heart Rate' dan 'Electromyograph' (EMG). Kesemua penilaian ini dibuat untuk ujian saringan dan sebagai maklumat asas pra-intervensi. Mereka kemudiannya dibahagikan secara rawak dan sama rata kepada tiga kumpulan; viz Kumpulan A – Kumpulan kawalan; Kumpulan B, yang menerima latihan intervensi maklum balas bio 'Electromyograph' (EMG) dan Kumpulan C, yang menerima latihan intervensi maklum balas bio 'Heart-Rate'. Semua peserta diperkenalkan dengan protokol program latihan yang telah ditetapkan (20min/hari, 2 hari/ minggu, selama 6 minggu). Peserta dalam kumpulan A tidak menerima sebarang laihan intervensi. Penilaian tahap pertengahan untuk semua pembolehubah telah dijalankan selepas 3 minggu latihan intervensi tersebut bermula. Kemudian, intervensi berjalan seperti biasa selama 3 minggu lagi sekaligus mencukupkan jumlah latihan 6 minggu dan satu penilaian akhir dibuat menggunakan protokol yang sama. Berdasarkan hasil keputusan melalui pemerhatian terhadap para peserta, kajian ini menunjukkan bahawa intervensi maklum balas bio EMG dan HR dapat memberi manfaat dalam prestasi kemahiran bola sepak. Kedua-dua intervensi tersebut dilihat dapat mengubah ciri-ciri psikobiologi para peserta, serta dapat meningkatkan kemahiran psikomotor sekaligus memberi peningkatan dalam prestasi kemahiran ketangkasan dan menyepak bola.

CHAPTER 1

INTRODUCTION

1.1 STUDY BACKGROUND

Soccer, for long time is known as the most popular sport in the world, which has immense popularity in Malaysia. International competition is regulated by the Fédération Internationale de Football Association (FIFA; founded 1904), which sponsors the quadrennial (since 1930) World Cup competition and whose membership is larger than that of the United Nations.

Performance excellence in soccer depends on acquisition of certain basic skills, such as- dribbling; juggling; running with the ball; heading; passing; receiving etc. Successful performance in soccer may be scientifically explained as the resultant of optimal level of positive transfer of correct responses (learned skills) from practice to competitive situations (Saha et al. 2005). This optimal positive transfer of correct responses is not an automatic process, since environmental hindrances result in perception of stress in the player. Coping with stressful competitive situations is considered as natural ability of the players, yet without effective stress management skills the effect of stress on the emotional response and performance consequences for the player may be severe (Eubank & Gilbourne, 2003).

People's ability to influence their psychological states has been given the term mental control (Wegner and Pennebaker, 1993). Mental control involves the delibrate use of strategies to change or maintain thoughts, feelings, or actions (Totterdell and Leach, 2001). The use of mental control strategy is now have been seen as an influential contributor to successful competitive performance in sport. Coping with stressful competitive situation is considered as natural ability of the players, yet without the

effective stress management skills the effect of stress on the emotional response and performance consequences for the player may be severe (Eubank and Gilbourne, 2003). Researches on stress process, as viewed in the Sport Psychology literatures, have mostly been dealt with the apprehensive feelings and negative expentancies in the players, which are commonly considered as aspects of anxiety.

Anxiety as a negative psychological state has been identified as multi-dimensional, viz. – cognitive (mental) and somatic (physiological) components, which respond differently to the stressors within the environment (Martens et. al., 1990). Theoretical considerations pertaining to impact of stress and anxiety subsequent performance failure have arguably most viably been discussed in the 'Catastrophe Theory' (Hardy et. al., 1994; Hardy et. al., 1996). Athlete needs to overcome this problem by using several types of mental training. Many of the mental control techniques used by sports performers require them to regulate their moods or emotions. This can involve the performer getting into the 'right' mood for competition or can involve gaining control over counter-productive emotions such as fear and tension (Totterdell and Leach, 2001).

Biofeedback training can help in regulating heightened emotionality. The supposition behind the use of emotion o regulation technique is that, there is a relationship between emotion and performance, which can be affected by performers controlling their mood states (Totterdell and Leach, 2001). More specifically, emotional regulation is thought to influence performance because it enables people to get into the sort of positive mood that facilitate certain cognitive proccesses (Matthews, 1992), which in turns increases the efforts and persistence on task (George and Brief, 1996).

Biofeedback is a therapeutic intervention that has become increasingly popular over the last fifty year. American Neal E. Miller (1909 – 2002) is often credited with first suggesting that people could train and control certain signals in the body just as they control movements of the body. Biofeedback is a technique that measures bodily fuctions such as breathing, heart rate, blood pressure, skin temperature and muscle tension. It teaches how to control and change these bodily functions. By doing so, individual feel more relaxed and may be able to help individual's own high blood pressure, tension and migraine headache, chronic pain or urinary incontinence (National of Institutes of Health, 2006). Typically biofeedback treatment is offered to patients who fail to respond robustly to medications or is used as an adjunct to pharmacotheraphy.

Biofeedback is the use of instruments to detect and amplify specific physical states in our body that we usually don't notice and to help bring them under our voluntary control. Biofeedback machines give us immediate information about such biological conditions, such as muscle tension, skin surface temperature, blood pressure, heart rate etc. The feedback from the instruments provides us with instant and continuous information so that we can observe and modify our physical experience of stress.

Biofeedback is often used as a supplement to many of the relaxation exercises. After one has used biofeedback instruments to develop his or her ability to read the tension in various body systems, he or she can continue it without a machine. If one start out to thinking that biofeedback machine can magically erase tension from the body, he or she may end up very frustrated. That because there are basically two steps in relaxation: first to identify when and where the tension is inside individual's body, and then to let go of it.

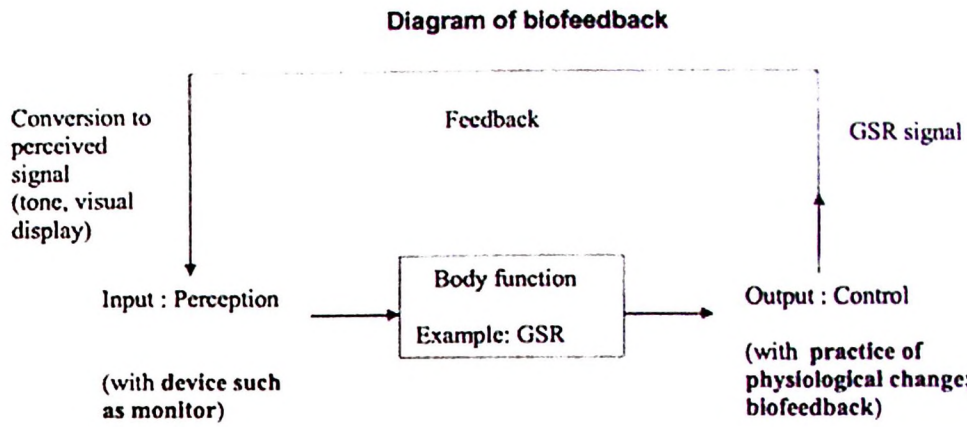

Figure 1: Diagram of Biofeedback

Biofeedback can reduces some physiological and psychological problems, such as, tension, headache, attention deficit disorder, migraine headache, any type of pain management, hypertension , panic attacks, insomnia, gastrointestinal disorders, muscle spasms, anxiety, phobic reaction, asthma, stutter (stammering) etc.

Neuromuscular Stability or Neuromuscular activation impairments may impact movement velocity and muscle coordination, leading to a reduction or a longer time to reach peak force and, thus, a decline in muscle power generation. In two recent investigations, we have defined operationally neuromuscular activation as the process by which the nervous system produces muscular force through recruitment and rate coding of motor units (Clark et. al., 2010; 2011) . Clark et. al., (2010) delineated the relationship between the neuromuscular system and muscle power generation within older adults with mobility limitations, healthy middle-aged adults, and healthy older adults.

The combination of the nervous system and the muscles, working together to permit movement, is known as the neuromuscular system. The brain controls the movements of skeletal (voluntary) muscles via specialised nerves. If an individual want to move, even if any of the body part, a message is sent to the particular neurons (nerve cells), called upper motor neurons. Upper motor neurons have long tails (axons) that go into and through the brain, and into the spinal cord, where they connect with lower motor neurons. At the spinal cord, the lower motor neurons in the spinal cord send their axons via nerves in the arms and legs directly to the muscle they control. A typical muscle is serviced by anywhere between 50 and 200 (or more) lower motor neurons. Each lower motor neuron is subdivided into many tiny branches. The tip of each branch is called a presynaptic terminal. This connection between the tip of the nerve and the muscle is also called the neuromuscular junction. The electrical signal from the brain travels down the nerves and prompts the release of the chemical acetylcholine from the presynaptic terminals. This chemical is picked up by the special receptors in the muscle tissue. If enough receptors are stimulated by acetylcholine, the muscles will contract.

Neurofeedback is a type of biofeedback that measures brain waves to produce a signal that can be used as feedback on brain activity to teach self-regulation. Neurofeedback is commonly provided using video or sound, with positive feedback for desired brain activity and negative feedback for brain activity that is undesirable.

Neurofeedback is direct training of brain function, by which the brain learns to function more efficiently. We observe the brain in action from moment to moment. We show that information back to the person. And we reward the brain for changing its own activity to more appropriate patterns. This is a gradual learning process. It applies to any aspect of brain function that we can measure. Neurofeedback is also called EEG Biofeedback, because it is based on electrical brain activity, the electroencephalogram,

or EEG. Neurofeedback is training in self-regulation. It is simply biofeedback applied to the brain directly. Self-regulation is a necessary part of good brain function. Self-regulation training allows the system(the central nervouse system) to function better.

Neurofeedback is a type of biofeedback that measures brain waves or brain blood flow to produce a signal that can be used as feedback on brain activity to teach self-regulation. Feedback is commonly provided using video or sound, with positive feedback for desired brain activity and negative feedback for brain activity that is undesirable. It refers to a specific operant-conditioning paradigm where an individual learns how to influence the electrical activity (frequency, amplitude or synchronization) of his brain (Pop-Jordanova and Demerdzieva, 2010). The brain's electrical activity is simply relay to the computer, so that no electrical current is put on the brain. Neurofeedback has been shown to be particularly useful in reference to pathologies characterized by disfunctional regulation of cortical arousal, such as epilepsy and attention deficit hyperactivity disorder (Pop-Jordanova, 2009).

The goal of neurofeedback training is to teach the individual what specific states of cortical arousal feel like and how to activate such states voluntarily (Vernon, 2005). For example, during neurofeedback training the EEG is recorded and the relevant components are extracted and fed back to the individual using an online feedback loop in the form of audio, visual or combined audio-visual information. Such a format is able to represent each of the relevant electrophysiological components separately: for example, as a bar with the amplitude of a frequency represented by the size of the bar. The individual's task may then be to increase the size of the training-frequency bar and simultaneously decrease the size of the bars representing inhibitory-frequencies. On meeting this goal, a tone may sound and a symbol appear to indicate a point scored, with the aim to score as many points as possible. It has been suggested that research

aimed at enhancing performance has a number of distinct aims, these include controlling the level of arousal, attention and motivation, optimising the level of autonomic control, and the ability to shift states at will, as well as developing rehabilitative interventions for athletes suffering injury (Landers, 1985; Norris and Currieri, 1999; Wilson and Gunkelman, 2001). The underlying rationale of using neurofeedback training to enhance performance is one based on associations. By identifying associations between particular patterns of cortical activity and specific states or aspects of behaviour that are classified as 'optimal,' one can attempt to train an individual to enhance performance by mirroring the pattern of cortical activity seen during such optimal states.

An electromyograph (EMG) biofeedback uses surface electrodes to detect muscle action potentials from underlying skeletal muscles that initiate muscle contraction (Florimond, 2009). Clinicians record the surface electromyogram (SEMG) using one or more active electrodes that are placed over a target muscle and a reference electrode that is placed within six inches of either active. The SEMG is measured in microvolts (millionths of a volt). In addition to surface electrodes, clinicians may also insert wires or needles intramuscularly to record an EMG signal. While this is more painful and often costly, the signal is more reliable since surface electrodes pick up cross talk from nearby muscles. The use of surface electrodes is also limited to superficial muscles, making the intramuscular approach beneficial to access signals from deeper muscles. The electrical activity picked up by the electrodes is recorded and displayed in the same fashion as the surface electrodes. Prior to placing surface electrodes, the skin is normally shaved, cleaned and exfoliated to get the best signal. Raw EMG signals resemble noise (electrical signal not coming from the muscle of interest) and the voltage fluctuates, therefore they are processed normally in three ways:

rectification, filtering, and integration. This processing allows for a unified signal that is then able to be compared to other signals using the same processing techniques. The principles of EMG biofeedback are usefully reviewed, as a reasonable understanding of what the machine is doing will assist the therapist in determining the most appropriate machine settings and applications.

Heart rate biofeedback is an approach that has appeared increasingly in the scientific literature over the last 20 years (Dishman, 1987; Whaley, 1990; Yamaji et. al., 1992). Recent popularity of heart rate monitors as a tool to provide biofeedback, researchers have been attracted to heart rate biofeedback as a possible novel or adjunct strategy to increase an individual's ability to accurately estimate and self-regulate their physical activity intensity (Dishman, 1987; Whaley, 1990; Illaraza et. al., 2004).

1.2 SIGNIFICANCE OF THE STUDY

In present situations stress in competitive sports is mostly obvious. Cognitive demands to meet the performance achievement targets put young performers and athletes under immense emotional turmoil, increased life-stress, anxiety, insomnia, autonomic crises and eventually may result in psychological breakdown. This study will focus on the evaluation of psychological as well as psychobiological factors inherent in cognitive-emotional make-ups of the players. Furthermore, psychobiological and psychomotor pathways related to disruptive emotionality and the related motor coordination crises will be authentically scrutinized. Besides, the present study will focus on the use of psychotherapeutic interventions such as Heart Rate (HR) Biofeedback and Electromyograph (EMG) Biofeedback therapy in enhancing emotional

regulation which in turn may facilitate in improvement of coordinated performance in young-adult soccer performers.

1.3 OBJECTIVES OF THE STUDY

1.3.1 GENERAL OBJECTIVE

To study the effect of differential efficacy of Neurofeedback and Biofeedback intervention on soccer performance.

1.3.2 SPECIFIC OBJECTIVES

a) To observe the effect of Electromyograph (EMG) Biofeedback training in improving the performance of soccer skills.

b) To see the effect of Heart Rate (HR) Biofeedback on improvement in proprioception and musculoskeletal functioning in the young-adult soccer players.

c) To compare the efficacy of Electromyograph (EMG) Biofeedback and Heart Rate (HR) Biofeedback onto the coordination ability of the young adult soccer players.

1.4 RESEARCH HYPOTHESIS

Null Hypothesis (H_O)

i) No significant effect of Electromyograph (EMG) Biofeedback training in improving the performance of soccer skills.

ii) No significant impact of Heart Rate (HR) Biofeedback training on improvement in proprioception and musculoskeletal functioning in the young-adult soccer players.

iii) No differences in the outcomes of Neurofeedback and Biofeedback intervention onto the coordination ability of the young adult soccer players.

Alternative Hypothesis (H_A)

i) Significant beneficial impact of Electromyograph (EMG) Biofeedback training in improving the performance of soccer skills.

ii) Significant positive effect Heart Rate (HR) Biofeedback training on improvement in proprioception and musculoskeletal functioning in the young-adult soccer players.

iii) Significant difference in outcomes of Neurofeedback and Biofeedback intervention onto the coordination ability of the young adult soccer players.

CHAPTER 2

LITERATURE REVIEW

REVIEW OF THE PREVIOUS LITERATURES

The survey of literature gives an impression that the studies conducted in this area may broadly be divided into – 1) those concerned to see the effects of Electromyographic (EMG) Biofeedback and 2) Heart Rate (HR) Biofeedback on psychological variables, psychomotor, psychophysiological and performance skill related variables. Studies conducted with regard to psychological variables were designed to investigate the effects of Biofeedback and Neurofeedback on soccer performance.

This particular review will concentrate only on the effects of EMG Biofeedback and HR Biofeedback on soccer performance which could be revealed through different psychological and psychophysiological measures. Most pertinent and relevant literatures will be sub-summed here critically but less important studies will not be discussed in length.

2.1 LITERATURE REVIEW OF ELECTROMYOGRAPHIC (EMG) BIOFEEDBACK

Over recent years electromyographic (EMG) biofeedback units have become more widely available to physiotherapists and success has been reported in the literature with their use in treating certain musculoskeletal conditions (Wise et al., 1984). EMG is a method of recording and quantifying the electrical activity produced by the muscle

fibres of activated motor units (Sale at al., 1992). It is the actual depolarisation and repolarisation of the surface membrane of the muscle fibre which is the source of the electrical potential changes detected (Clarys and Cabri, 1993). The EMG signal recorded can be significantly affected by physiological parameters such as motor unit recruitment, intervening fatty tissue, muscle temperature, muscle cross- sectional area and length. Electrode type, size, location and spacing as well as the amplification and filtering processes can also alter the signals detected (LSUMC, 1995).

A combination of Electroencelograph (EEG) and EMG biofeedback was used for peak performance in musicians (Markovska-Simoska S, Pop-Jordanova N, Georgiev D., 2008). Other research has also documented the potential of neurofeedback in enhancing optimal performance in high level musical performers (Egner T, Gruzelier JH. , 2003) and in dance performance (Raymond J, Sajid I, Parkinson LA, Gruzelier JH., 2005).

Studies on impact of biofeedback and improvement in sport performance by and large focused on EEG alpha biofeedback and Heart rate biofeedback, while EMG measures were mostly considered for obtaining information related to sports injury rehabilitation only. (Dustman et al., 1990a; Dustman et al., 1990b). Bar-Eli & Blumenstein (2004) using EMG biofeedback only for 10 weeks, observed improvement in running and swimming performance in young adolescents (aging between 16 -18 years), while Blumenstein & Tenenbaum (1995) observed improvement in athletic performance in college students, using EMG biofeedback for only 13 sessions. Further to that, Blumenstein et al., (1995) observed that only 6 sessions of frontalis EMG biofeedback and HR biofeedback can ensure improvement in psychophysiological

parameters, such as, GSR; HR and BP etc, as well as improved athletic performance in young college student performers.

Available dearth of research literatures dealing with impact of biofeedback on sports performance revealed that attempts have been made to employ EMG biofeedback, but researches employing HR biofeedback on performance enhancement are still scanty in number. Furthermore, none of the biofeedback related researches were done on Asian and/or South-East Asian population. More so, the question of how many biofeedback sessions could be considered as sufficient for the young adult student population is not yet clear to us.

Key members of the Italian national soccer team that had won the World Cup back in 2006 utilized a number of biofeedback and neurofeedback techniques labeled "the Mind Room", with Dr. Brunoo Demichelis, the head of AC Milan Sport Science as the administrator of the program. The objective is to integrate biofeedback and neurofeedback into common practices of sport psychology by teaching the players to maintain correct breathing, relaxed muscles, and other skills (Vietta E. Wilson, Erik Peper, Hal Meyers, Donald Moss et. al., 2009). By having developing ritualized routines, these performances are more likely to become automatic (Singer, 2002). In order to score in penalty kicks, players should be remain calm but must stay alert and focused on the goal.

The assessment and training of body and mind responses is routinely done in 'The Mind Room' by monitoring EEG, EMG, Temperature, Heart Rate variability, blood volume pulse, EDA, respiration (Infiniti,Thought Technology) while the trainer guides the athletes through a series of relaxation and meditation exercises until they

learn to master a quiet meditative state, similar to what is labeled the zone of optimal functioning in the research literature (Kamata, Tenenbaum, & Hanin, 2002).

Thus, it becomes obvious that fewer of the studies actually paid attention to both EMG and electromyographic evoke-potential related neurofeedback and HR biofeedback as Cognitive-Motivational or Cognitive-Emotional Therapeutic Intervention model in enhancing ability of the soccer players in handling performance related crises. Furthermore, none of the afore-mentioned studies were focused onto enhancement in psychobiological efficiency in producing highly –skilled soccer performances in Malaysian as well as in South-East-Asian soccer performers.

A study investigated the effects of Electromyographic Biofeedback (EMG BFB) on reaction time and movement time and provided evidence of learning and improved performance through biofeedback in the experimental group (Schultz, et al. 1987). Several studies indicate that electromyographic (EMG) biofeedback can be a valuable adjunct to such exercise, enhancing motivation as well as muscle strength, tolerance, and flexibility (Krebs D.E, 1981; Sprenger CK, Carlson K, Wessman HC, 1979; Zaichkowsky LD, Fuchs CZ, 1988). In a study by Corce (1986), undergraduate volunteers received EMG biofeedback during isokinetic exercise of the quadriceps muscle group. After five weeks of thrice-weekly conditioning, these subjects demonstrated significantly higher peak torque values when compared to controls who exercised without EMG biofeedback. Another study with undergraduates. conducted by Lucca and Recchiuti (1983), examined the effects of EMG biofeedback on isometric contraction of knee extensors. Upon completing a 19 days of exercise program, experimental subjects displayed significantly greater gains in average peak torque than groups that were not given biofeedback.

Studies of clinical populations support the findings of research using healthy volunteers. For example, a study by Draper (1990) found that biofeedback assisted exercise following anterior cruciate ligament (ACL) reconstruction was superior to exercise alone. Eleven patients in this study received EMG biofeedback during quad sets and straight leg raising exercises, while a control group of equal number received the regular post-operative protocol for ACL injuries. After completing the 12-week program, the biofeedback group exhibited significantly greater strength acquisition. In addition, patients in this group achieved full range of motion in significantly less time than patients in the control group.

Another study (Draper V & Ballard L, 1991) demonstrated that surface integrated EMG feedback-assisted exercise was superior to electrical stimulation in promoting recovery following ACL reconstruction. Fifteen patients received EMG-feedback dueing quad sets and straight leg-raising exercises, while an equal number of controls exercised with electrical stimulation (ES) substituted for EMG-feedback. Post-tests upon completion of the 12-week program indicated that biofeedback group displayed significantly greater strength acquisition than controls, as tested by a Biodex 2 isokinetic dynamometer.

2.2 LITERATURE REVIEW OF HEART RATE BIOFEEDBACK

Heart rate is determined by the number of heartbeats per unit of time, typically expressed as beats per minutes (bpm). The variation of the heart beat depends on the physiological condition and body's need for oxygen changes, such as during exercise or resting condition. Heart rate also varies in each individual, for example the heart beat for athlete and for non-athlete.

Jones (1994) cited that heartbeat sensations are tranduced by receptors sensitive to mechanical stimuli produced by the ventricular contraction. Cardiovascular effects, especially noticeable increases in heart rate (HR) and stroke volume, are hallmark of anxiety (Goodwin and Guze, 1979). Heart beat is influenced by stroke volume and momentum (blood mass times velocity) (Schandry et. al., 1993).Visual HR feedback quickly facilitated heart rate control during the second phase without consistent corresponding change in skin conductance. (Carl et. al., 1998).

From the previous study, it has been shown that patients with anxiety disorders may experience symptom reductions with biofeedback training (Bont JI, Castilla CD, Marañón P et. al., 2004, Telch MJ, Valentiner DP, Ilai D, Petruzzi D, Hehmsoth M et. al., 2000). In this context, HR Biofeedback can be valuable and beneficial in sports performance as it could be used as an emotion regulation strategy selectively targetting the physiological reaction elicited by an emotional stimuli or situations.

Biofeedback may transfer to other stressful situations although the heart rate is not monitored by the subject, after a few training were done (Sharpley CF 1994). However, the subjects were not only trained just by biofeedback but also informed about visualization, breathing and relaxation techniques to control and regulate heart

rate. Thus, because they continue on practising those techniques, they had become easier to control the heart rate without biofeedback.

Perceiving intensity of physical activity can be a difficult task particularly for children who are not as cognitively mature as adults, (Welk et. al., 2000) and research has shown that most children are not instinctively (i.e. without practice) capable of accurately recognising and monitoring their intensity of physical activity (Cowden and Plowman, 1999; Williams et. al., 1991). Conley et. al., (2010) reported that children (age between 11–13 years) had a difficulty in accurately estimating time spent in moderate-to-vigorous intensity activity (MVPA). This study was done on 37 childrens who had no previous training in the self-identification of physical activity intensity, nor any prior experience using heart rate (HR) monitors. Furthermore exposure of six sessions of heart rate biofeedback did not improve children's ability to estimate this response. Thus estimating time spent in MVPA remains a difficult task for some children even with the help of heart rate biofeedback because the participants not having the cognitive ability to respond to the HR biofeedback.

It has been shown that imagining fearful scenes (Lang et al., 1970) and painful scenes (Craig, 1968; Fenz and Dronsejko, 1969) increases heart rate. Thinking about self-induced stressful words also increases heart rate (May and Johnson, 1973; Schwartz, 1971), whereas thinking about self-induced relaxing words decreases heart rate (May and Johnson, 1973). It may be that the magnitude of heart rate changes to contextually complete images is a function of the specific qualitative characteristics of the image in question (Jones and Johnson, 1978).

In previous studies, it has been difficult to elicit decelerative responses comparable in magnitude to accelerative responses (Bell and Schwartz, 1975; Blanchard

and Young, 1973; Furedy and Klajner, 1978), possibly because heart rate increases and decreases are mediated by different physiological mechanisms (Bell and Schwartz, 1975; Brener. 1974; Engel, 1972; Lacey and Lacey, 1978; Lang, 1974), or are differentially sensitive to other mediating factors such as somatic maneuvers.

Heart Rate Variability (HRV) Biofeedback (BFB) directly targets and modulates activity of the autonomic nervous system. Efficacy of HRV BFB has been tested in a golfer to reduce competitive stress and anxiety. The results of the case study suggested that HRV BFB training may help the athlete to cope with stress and anxiety experienced before and during the competition (Lagos, et al. 2008). Similarly, previous HRV BFB researches have also addressed optimization of maximum heart rate oscillations at varying resonant frequencies to enhance athletic performance (Raymond, et al. 2005; Strack, 2003; Vaschillo and Rishe, 1999). Maman, et al. (2012) used HRV with 30 basketball players (Male=16, Female=14) ranging in age from 18 to 28 years and concluded that HRV dynamics is particularly sensitive to changes in emotional states so an optimally relaxed state of mind may have potentially influenced substantial improvements in an athlete's concentration, shooting performance and response time.

SUMMARY OF LITERATURE REVIEWS

In this experiment we wanted to see the relative impacts of the differential neurofeedback and biofeedback therapeutic treatment regimes on soccer players performance.

Self-report indices are often time-consuming, not culture-free and not free from personal biasness. Further to that, Malaysian standardised inventories are scanty in numbers and are not readily available in wide-ranges of population, and hence, without relying heaviliy on subjective self-report indices, we attempted to go for self-report analysis along with substantiated objective evaluation of emotionality, in order to identify the nature of psychological as well as psychophysiological changes in young-adult soccer players. Apart from that, emotional changes like any other psychological processes, are not only psychological but also biological phenomena. An individual's personality and emotionality is related to numerous neurobiological procesess, including regulation of neurotrasmitter systems (Hollander & Evers, 2001; Carver & Miller, 2006; Netter, 2006), hormones (Zuckerman et. al., 1980; Rubinow & Schmidt, 1996; Biondi & Picardi, 1999; Griffiths et. al., 2000), as well as of autonomic (Eysenck, 1990; Lorber, 2004), and immune system activity (Alder & Matthews, 1994; Segerstrom, 2000; Kiecolt-Glaser et. al., 2000a,b; Ader, 2006). Personality is also related to the activity of peripheral organs, especially via the hormonal and the autonomic nervous systems (Verrier & Mittelman, 2000; Armour & Ardell, 2004). The organ that has been most extensively investigated in this regard is the heart. It is well documented that emotional processes affect a variety of parameters of heart rate activity, such as Heart Rate Variablity (HRV) and contractility (Cacioppo et. al., 2000; Verrier & Mittelman, 2000; Armour & Ardell, 2004). A substantial body of evidence indicates that affective disorders such as anxiety and depressive disorders are associated

with reduced HRV, as well as reduced QT variability (Friedman & Thayer, 1998; Yeragani et. al., 1993, 2000; Carney et. al., 2001), and that chronic negative emotions such as fear, hostility, depression and anger increase the risk for coronary heart disease and heart attack (Lesperance at. al., 1996; Rozanski et. al., 1999; Kubzansky & Kawachi, 2000; Macmahon & Lip, 2002; Singh et. al., 2002; Joynt et. al., 2004; Smith et. al., 2004; Rozanski & Kubzansky, 2005; Stanton et. al., 2007).

Finally to summarise, it must be acknowledged that critical scrutiny of the available literatures so far revealed that psychotherapeutic interventions, with particular emphasis on introduction of biofeedback training on improvement in neuromuscular stability; steadiness and/or dexterity has been largely ignored. Although few attempts have so far been reported, those have only considered EMG biofeedback intervention for treatment of patients having serious neuromuscular limitations.

CHAPTER 3

METHODOLOGY

3.1 GENERAL METHODOLOGY

Introduction

In this present study, assessment of the existing psychological make-up of the participants was attempted in two ways: subjective experiences of transitory state of anxiety and anxious predisposition and using self-report indices. Objective assessment of attention performance of the participants and their capacity to regulate autonomic arousal were also done. This was done, particularly for the reason that, the participant might face a little problem in revealing their inner state of psychological crises, accurately enough, through self report indices. To eradicate this problem it was felt necessary to judge their inner psychobiological assessment and reaction time measures. It was postulated that changes in psychobiological make-up of the participants, as could be revealed through subjective self report (using structured inventories, viz, State-Trait Anxiety Inventory – STAI); would be corollary to that obtained on the objective physiological assessment viz, skin Resistance (SR), electromyography (EMG) and heart rate. Apart from that, attention level of the participant was assessed through Reaction Time (RT) and different psychomotor parameters were measured. Detailed description of all of the assessments done is the following.

3.2 SECTION A

3.2.1 The State – Trait Anxiety Inventory (STAI)

Introduction

This inventory was designed by Spielberger et. al., (1970) to provide the reliable means of distinguishing between two distinct aspects of anxiety, viz. State – Anxiety (SA) and Trait – Anxiety (TA). The SA is conceptualised as a transitory level of anxiety, which is often situationally determines and fluctuates with time and circumstances. Whereas the TA is regarded as a relatively stable individual characteristics.

Design And Development

The directions used with the two forms are to ask the participant to indicate how he feels 'right now' (State anxiety) or how he 'generally feels' (Trait anxiety). On the state anxiety form, the participant is required to respond to each items in terms of severity (not at all, somewhat, moderately and very much so). On the trait anxiety form, the participant responds in terms of frequency categories (almost never, sometimes, often and almost always). In both forms these categories are assigned numbers from 1 to 4.

Administration And Scoring

Either scale can be used by itself. However, when using both together, it is recommended that the state anxiety form be administered first (Spielberger et. al., 1970). The inventory is self administering (either individually or in groups). Though there is no time limit, completion of both forms seldom requires not more than twenty minutes. In both forms some of the items are worded in such a way that a response of 1 indicates little anxiety or absence of anxiety and response of 4 indicates high anxiety. Other items are worded so that a response of 1 would indicate high anxiety. The simplest way to score is to add the rating given to the direct items and reversed items separately and then subtract the sum of the reversed items from the sum of the direct items and to add a constant. If the subjects fail to respond to one or more items, a

complicated procedure for scoring has been recommended (Spielberger et. al., 1970). It should be mentioned here that all the participants used in the present study understood very well the instructions given to them while filling the forms, and none of them failed to answer any one of these items mentioned in both forms.

Interpretation

The score of either forms can range from 20-80, the higher the score, the greater is the level of anxiety.

3.3 SECTION B

3.3.1 Reaction Time

Introduction

One of the most available response variables for experimental psychology is speed. The reason is obvious : every act takes time and time can be measured. We can measure the time occupied in doing a certain amount of work, or we can set a limit and measure the amount of work done in the given time. In either case we measure the speed of work. Speed is a useful measure in two ways : a) as an index of achievement; the more completely one can master a task the more rapidly one can perform it; and b) as an index of the complexity of the inner process by which a result is accomplished; the more complicated the process, the longer time it will take. For such reasons the timing of response play an important role in psychological experimentation. Reaction time is about the simplest case of timing (Woodworth and Schlosberg, 1976)

Reaction time is not exactly what might supposed from the term. It is not the time occupied by the execution of a response. It is the time required to get the overt response started. The reaction is the S – R time interval. The response can not come out of the organism quite soon as the stimulus goes in. The stimulus starts a process going, but the process remains hidden or 'latent' inside the organism till it reaches the muscle and procedures an observable effect on the environment. The sense organ must be aroused to activity, the nerves must conduct to the brain and from the brain to the muscles and the muscles must contract and move some external object. All these process involve a neural delay in information processing. Even in the simplest possible

reaction time, nerve impulses coming in from the sense organ have to accumulate and build up enough excitation to arouse the motor areas of the brain and set up a discharge toward the muscles. When the response has to be nicely adjusted to the stimulus, work is done and time is consumed in registering the exact character of the stimulus and organising the motor response. The reaction time, also called the response latency, includes sense organ time, brain time, nerve time and muscle time (Woodworth and Scholsberg, 1976).

The use of reaction as an index of cognitive preformance change due to an exercise conditioning treatment was selected because it reflects a number of CNS conditions theoretically influenced as well by exercise – induced physiological adaptation (Schubert, 1981). Schubert (1981), and Khan (1987) are a few amongst many sport scientists who have directed their efforts toward examining this expect. Sandhu (1981) found that increased arousal level reflects back in perceptual activity of the player's leading to various errors. Chattopadhyay (1973) also used R as a CNS arousal measure. Reaction time is a factor in predicting sensilitty (Ferris et. al., 1976), it declines with age (Talland, 1965), and shows in conjuction with an increase in the severity of cardio-vascular disease (Abrahams and Birren, 1973; Birren and Spieth, 1962). In short, reaction time measures provide a broad index of how effectively the CNS is functioning (Marteniuk, 1976).

Description Of The Apparatus

The reaction time of the participants in both visual and auditory modalities were assessed by using 'Udyog Reaction Timer'. This response timer has two different units – a) one gazette used by the experimental procedure and as the timer unit to assess and provide information regarding the time lapsed between stimuli presented and response done (Unit A); and b) one gazette for the participant to respond the stimuli presented by the experimenter (Unit B).

The experimenter's gazette contains ine panel board having eight push button switches, of which six are for six corresponding lights and others two are auditory stimulation. At the front part of the gazette, there is a thumb – wheel switch that enables the experimenter to adjust the foreperiod according to the experimental requirement. The second gazette, i.e. the participant's unit contains a panel – board with six lights (having six different colours), just opposite which there are six switches corresponding