COMPARATIVE EFFICACY OF VISUOMOTOR BEHAVIOUR REHEARSAL, BIOFEEDBACK AND COMBINED INTERVENTIONS IN PERFORMANCE OF YOUNG ATHLETES IN EAST COAST OF MALAYSIA

FOUJIA HUDA

UNIVERSITI SAINS MALAYSIA

2022

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by

FOUJIA HUDA

A thesis submitted in fulfilment of the requirements

for the degree of

Doctor of Philosophy

JUNE 2022

ACKNOWLEDGEMENT

Firstly, I would like to express my sincere gratitude, appreciation, and indebtedness to my main supervisor Professor Dr Hairul Anwar Hashim, Professor DrSoumendra Saha, and Professor Dr Srilekha Saha for all their support, patience, motivation that they have showered upon me during my PhD study and related research. Guidance from all of them helped me in all the time of research and writing of this thesis.

I would like to express my utmost gratefulness to Universiti Sains Malaysia forproviding me with financial support in carrying out my research (Fundamental ResearchGrant and BISS International Research Grant). I would always genuinely and respectfully acknowledge the kind and prudent decision of the authority of the Ministry ofYouth and Sports, Govt. of Bangladesh, and the authority of Bangladesh Institute of Sports (Bangladesh Krira Sikkha Protisthan -BKSP), under the Ministry of Youth andSports, Govt. of Bangladesh, to permit me to carry out my PhD study. Further to that,my sincere admiration goes to Mr Faruqul Islam, National Director of Special Olympics for encouraging me to join the PhD programme.

My heartfelt gratitude to Dr Ms Faria Sultana, Dr Maruf Ahmed Mridul, Dr Naresh Bhaskar Raj and Mrs Nurfarah Ezzaty Bt Mohd Zahir, who havealways been there extending their valuable support at various phases of my research. Apart from that, I also would like to extend my heartfelt thanks to the Chief coach of the Dept. of Athletics and all other chief and Senior coaches and all my colleagues at BKSP.

Last but not the least, I would like to thank my family: my mother, my sisters, brothers, and other family members for supporting me spiritually throughout this journey and in life.

Foujia Huda
June 2022

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LIST OF ABBREVIATIONS

ANS	Autonomic Nervous System
BAS	Behavioural Activation System
BF	Biofeedback
BIS	Behavioural Inhibition System
BP	Blood Pressure
BRUMS	Brunel Mood Scale
CI	Confidence Interval
CONSORT	Consolidated Standards of Reporting Trials
EDA	Electrodermal Activity
EEG	Electroencephalogram
EMG	Electromyography
HR	Heart Rate
HRmax	Heart Rate Maximum
HRV	Heart Rate Variability
MSN	Majlis Sukan Negara
MVC	Maximum Voluntary Contraction
NA	Not Available
PEDro	Physiotherapy Evidence Database
PETTLEP	Physical, Environment, Task, Timing, Learning, Emotion, Perspective
pg	Page
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PST	Peripheral Skin Temperature
RCT	Randomized Control Trial
RO	Research Objective
Sc	Skin Conductance
SD	Standard Deviation

secs	Seconds
SEMG	Surface Electromyography
SENIAM	Surface Electromyography for Non-invasive Assessment of Muscles
SNOSE	Sequentially Numbered, Opaque, Sealed Envelopes
SPSS	Statistical Package for the Social Sciences
USM	Universiti Sains Malaysia
VMBR	Visuo-Motor Behaviour Rehearsal
ZOF	Zone of Optimal Functioning

PERBANDINGAN KEBERKESANAN LATIHAN TINGKAH LAKU VISUOMOTOR, BIOFEEDBACK DAN GABUNGAN INTERVENSI TERHADAP PRESTASI ATLET MUDA DI PANTAI TIMUR MALAYSIA

ABSTRAK

Kajian ini dijalankan untuk menyiasat keberkesanan latihan tingkah laku visuo-motor (VMBR), jika ada, mengenai tindak balas ideomotor yang berkaitan dengan kesilapan lakuan prestasi dalam peserta. Pengenalpastian hubungan yang rumit antara fisiologi; psikofisiologi; psikomotor dan prestasi fizikal telah dilakukan di kalangan atlet dewasa yang berpotensi tinggi di Malaysia. Seramai dua puluh atlet telah direkrut sebagai peserta, yang disediakan dengan maklum balas audio-visual yang berkaitan dengan kesilapan lakuan prestasi, diikuti dengan penilaian parameter fisiologi (iaitu kardiovaskular, langkah-langkah rangsanagan autonomik) dan ciri-ciri psikologi dan psikomotor yang bersesuaian (iaitu kelenturan kognitif, kebimbangan, keupayaan tindak balas, koordinasi motor dan pergerakan, keadaan mood dan kestabilan emosi) berhubung dengan kecemerlangan prestasi. Penilaian electrodermal untuk menguji tindakbalas refleks, analisis elektromyografi yang menimbulkan potensi telah dilakukan. Seterusnya, semua peserta diperkenalkan dengan kesilapan pergerakan mereka. Selepas itu, mereka secara rawak dikategorikan kepada empat kumpulan, iaitu. satu kumpulan kawalan tanpa intervensi; Kumpulan eksperimen I - yang menerima latihan VMBR sahaja; Kumpulan eksperimen II menerima latihan latihan biofeedback komposit dan para peserta Kumpulan III yang menerima latihan VMBR bersama-sama dengan biofeedback. SEmua kumpulan mengikuti protokol latihan yang sama iaitu, 15 minit / hari, 2 hari / minggu selama 20 minggu. Analisis pertengahan bagi semua pemboleh ubah telah dilakukan pada akhir minggu kesepuluh,

diikuti penilaian penilaian intervensi, yang dilakukan pada akhir minggu kedua puluh. Kesan intervensi jangka panjang dinilai melalui penilaian susulan pos. Anaolisa berulang ANOVA dan Analisa Ramalan Struktur telah dilakukan untuk mendedahkan proses psikobiologi integral yang menegaskan ketakutan tidak sedarkan diri terhadap kebimbangan yang membawa kepada prestasi olahraga bencana. Hasil daripada penyelidikan ini akan mengenal pasti teknik intervensi yang ideal untuk digunakan dalam meningkatkan kemahiran motor persepsi kognitatif di atlit. Analisa berulang ANOVA dua faktor mendedahkan bahawa, latihan VMBR menyumbang dalam peningkatan harga diri, memberi kesan yang menyenangkan dan menghasilkan tahap kelenturan emosi yang tinggi yang berkaitan dengan perubahan impulsif dan kerengsaan yang jelas di kalangan atlet. Pada masa yang sama, biofeedback meningkatkan kecekapan psikobiologi (autonomi) dalam kalangan atlet yang yang mempunyai harga diri yang lebih rendah; krisis somatisasi; tindak balas autonomik; tahap kepuasan yang lebih rendah dan tahap perasaan yang mencurigakan yang agak tinggi. Selain itu, gabungan latihan VMBR dan Sc biofeedback didapati berkesan dalam menghasilkan ketangkasan, kelajuan dan kuasa puncak yang lebih cepat di kalangan atlet, yang tidak dapat dilihat dalam rakan mereka dalam kumpulan kawalan dan kumpulan intervensi lain juga.

COMPARATIVE EFFICACY OF VISUOMOTOR BEHAVIOUR REHEARSAL, BIOFEEDBACK AND COMBINED INTERVENTIONS IN PERFORMANCE OF YOUNG ATHLETES IN EAST COAST OF MALAYSIA

ABSTRACT

The present study was carried out to investigate the significance of visuomotor behaviour rehearsal (VMBR), if any, on the ideomotor response related to erroneous performance outcomes identified in the participants. Identification of intricate relationships between certain physiological; psychophysiological; psychomotor and physical performance factors was done among young-adult high-performing athletes of Malaysia. Fifty-two athletes were recruited and provided with audio-visual feedback related to their erroneous performance outcomes,followed by an assessment of physiological parameters (viz. cardiovascular, autonomic measures of arousal) and corresponding psychological and psychomotor attributes (viz. cognitive flexibility, anxiety, reaction ability; motor and movement coordination;mood states and emotional stability) about performance excellence. Electrodermal evaluation of orienting reflex and electromyography analyses of evoked potential was carried out. Thereafter all of the participants were introduced to the evaluation of their movement errors. After that, they were randomly categorized into four groups, viz. one no-intervention control group; Experimental (Ex.) group I – who received training of VMBR only; Ex. Group II received training composite biofeedback training and the participants of Ex. Group III received training of VMBR along with biofeedback, following an identical training protocol (i.e., 25

min.s/day, 2days/ week for 20 weeks). Midterm analyses of all of the baseline variables were done at the end of the tenth week, followed by post-intervention assessment, which was carried out at the end of the twentieth week. The sustainable impact of intervention techniques was evaluated by post-follow-up assessments. The Repeated measure of ANOVA was done to reveal the integral psychobiological processes underlying unconscious fear of apprehension leading toward dismal athletic performance. The outcome of this research will identify the ideal intervention techniques to be applied in improving the cognitively mediated perceptual-motor skills (for instance, serial skills involved in take-off and landing actions) in the athletes. A two-way repeated measure of ANOVA revealed that VMBR training contributed to the improvement of self-esteem, pleasant effect and resultant high level of emotional flexibility associated with changes in impulsivity and irritability evident among the athletes. Sc biofeedback, on the other hand, enhanced psychobiological (autonomic) competence in the athletes. This improvement was clear among the athletes who had relatively lower self-esteem; somatization crises (e.g., irritability, headache, pain, weakness etc.); autonomic startle response; lower extent of pleasantness and relatively higher extent of suspicious feelings. Apart from that, the combined intervention of VMBR and Sc biofeedback training was found effective in faster agility, speed and peak power output among the athletes, which were not evident in their counterparts in the no-intervention or control group and other intervention groups as well.

CHAPTER 1

INTRODUCTION

1.1 Background and Scope of the Study

In the world of sports and games, athletics, or athletic activities in general referto engagement in a particular group of competitive sporting events, which encompasses competitive and committed participation in activities, such as running, jumping, and throwing activities. The term athletics most commonly describes types of competitive events, viz., track and field, road running, cross country running and racewalking etc, although high and long-jumping events and throwing of javelins, discussand hammers etc., are also popular athletic events.

1.2 Athletic performance

Under this subheading, three issues are described. The first one pertains to background information on athletics in Malaysia that discusses problems associated with athletic performance outcomes in Malaysia. The second one refers to the athletes' ability to cope with negative stressors. The third issue concerns universally accepted psychological skill training strategies, usually practised by athletes.

1.2.1 Athletics in Malaysia

Malaysia is well-known for its athleticism, and the nation has been running several tertiary-level sports developmental programmes, including high-performance trainingprograms running in different Malaysia Sukan Negara (MSNs) in different provinces (viz., Kelantan, Terengganu, Kuala Lumpur etc.) in Malaysia. Despite an investment of a substantial amount of funds into the

training of athletes targeting high-performance achievement (BERNAMA, 2014),performance outcomes signify a trivial impact on the overall depth of athletic abilities (Ballard et al, 2016). Reports based on medals tally in regional international events held between 2002 to 2015, so far revealed that compared to the performance of athletes representing neighbouring nations, the performance of Malaysian promising and elite-level athletes revealed stagnancy or a gradual regressive trend (Ballard et al, 2016, Chong, 2008). In pursuit of the performance hindering factors, multiple aspects were highlighted, which ranged from internal conflicts among members and decision-makers in the sports associations and athletic federations (Yusof et al., 2009); to the inabilityto utilise high-tech scientific know-how in athletic training (Ballard et al, 2016), and inefficiency in availing sport scientific facilities and higher-order coaching strategies (Chong, 2008). Apart from all those assumptions and explanations of the impacts of extraneous factors, quite a few other contemporary researchers in this field of study, investigating South-East Asian athletes and players intended to explore individualistic aspects, such as the contribution of psychology (Bagherpour et al., 2012& 2013; Hossein et al., 2016; Jannah et al., 2018a & b; Saha et al., 2012a; Saha et al.,2013a); psychological and psychobiological (Saha et al., 2005; Saha et al., 2015a; Saha and Saha, 2015b; Saha et al., 2018a); psychobiological (Saha et al., 2012b & c; Saha et al., 2014; Saha et al., 2015c; Saha et al., 2018b); psychobiological and psychomotor(Hashim et al., 2010; Saha et al., 2012a; Saha et al., 2015d & e; Zahir et al., 2016a, b & c; Saha et al., 2018b) indices on physiological (Ghosh, 2004; Ghosh et al., 2010; Hashim et al., 2010; Woo et al., 2008) and physical performance (Zahir et al., 2016a & c) factors associated with dismal athletic performance outcomes. These kinds of

literature and numerous other findings highlighted individualistic approaches to identify performance inhibiting factors, and those researchers emphasized more disintegrated perceptual-cognitive, cognitive-emotional processes attenuating psychomotor coordination, by inhibiting discrete motor components involved in serial actions and eventually hindering optimal athletic performance outcomes.

1.2.2 The generalised ability of Athletes to cope with negative stressors

Successful performance of athletic skills in actual competitive situationsrefers to the outcome of optimal level of positive transfer of correctly learned andpractised skills (Eubank and Gilbourne, 2003). The regularised and tedious practice ofbasic skills, through continuous and dynamic practice sessions, become spontaneous (Eubank and Collins, 2000; Eubank and Gilbourne, 2003) and during actualcompetitive situations, players can perform those skills, as they perform from their own "zones of excellence" (Orlick and Partington, 1988 and Orlick, 1998 and Saha et al. 2005).

In the case of successful sports performance, the perception of stress is considered one of the most common and debilitating factors (Eubank and Gilbourne, 2003). Research on the stress process, as viewed in the Sport Psychology literature, has mostly dealt with the apprehensive feelings and negative expectancies in the players, which are commonly considered aspects of anxiety (Saha et al., 2005; Spielberger et al., 1972). For effective regulation of anxiety, numerous studies have been conducted, which have reported that mental training programmes in individual sports (Patrick & Hrycaiko, 1998; Terry, Mayer, & Howe, 1998) and team sports (Bakker & Kayser, 1994; Bull, 1995; Savoy, 1997) can lead to improved sports performance.

For any elite or top-level sports performer, it has become inescapable to face overwhelming stress due to immense workload, peer pressure, self-aspiration to exceland demands from the keens in their day-to-day lives (Eubank and Gilbourne, 2003). Athletes' ability to influence their psychological states mostly depends on cognitive-emotional control (Wegner & Pennebaker, 1993). Furthermore, the ability of anathlete involves the thoughtful and cautious use of strategies to change or maintain thoughts, feelings, or actions (Totterdell & Leach, 2001).

Here, a little bit of detailed emphasis is given to the affective-motivational aspect involved in sports cognition, which is primarily considered (Gray,1987a & 1987b) as the result of primordial fight-or-flight (F/F) responses. According to Gray (1987a & 1987b) sports cognition is essentially the precursor for both the BAS (behavioural activation system - the reward system) and BIS (behavioural inhibition system- the punishment or fear-eliciting system). From an Asian and especially South-Asian perspective, impulsivity and aggressive outbursts are considered conduct disorders. Thus, a docile tendency in children andpre-adolescent communities is more obvious that has susceptibility to lead them to acognitive-motivational make-up of BIS orientation involving sceptical and apprehensive feelings (Beauchaine, 2001, Beauchaine etal 2007 & 2008; Saha et al. 2005 & Saha and Saha 2010,2012a, b & c).

BIS is exclusively mediated by SNS projections, while BAS is controlled by both (sympathetic- SNS and Parasympathetic- PNS) autonomic outflows, and as Beauchaine and his co-researchers (Beauchaine et al 2007 & 2008) emphasized, subjective (individual-specific inconsistent) behavioural

manifestations required for successful sports achievements should be guided by both of these physiological systems (Saha et.al. 2005). Thus subjective transient or situation-dependent and situation-specific cognitive-affective responses involved in judgments during competitive events could be judged and predicted by corroborative interpretations of the arousal (both cortical and autonomic) mechanisms. Dispositional (relatively more stable and consistent) features of sportspersons are directed by motivational programming (inhibition-disinhibition) that determines corresponding behavioural manifestations. Klein and Thorne (2007) attempted to understand this phenomenon with EEG correlates of behaviour and could identify a positive relationship between the covert intention of athletes and theresultant motor responses. Whereas Cahn and Polich (2006) working with elite golferscould not arrive at a decisive conclusion. Studies of both Klein and Thorne (2007) and Cahn & Polich (2006) did not consider any corroborative psychological measure but only wanted to observe the changes in EEG patterns (transformation from Alpha waves to Theta and Delta waves followed by meditation) with differential levels of exercise activities, and not on the EEG processes involved behind thecompetitive sports behaviour.

1.2.3 Psychological Skill Training Strategies

Elite players are although considered capable of handling stressful situationsas favourable, effective coping with stressful competitive situations always requires effective stress management skills training (Saha et al., 2005; 2012a; 2013b; 2014; 2015d, e, & f; 2018a & c). There is a popular misconception amongst coaches, officials, peers, fans, and players themselves that coping with stress is a natural abilityof the players (Eubank & Gilbourne 2003; Saha et al., 2005; 2012a). Further to that, this misconception leads to a false belief that, elite

players are psychologically strong ormentally tough (Bandura, 1997; Kobasa et al., 1982; Sheard and Golby, 2010, Westman,1990), or they have hardy personalities (Hossein et al., 2016; Kobasa et al., 1982; Sheard and Golby, 2010). Thus, owing to these misconceptions and false beliefs majority of the elite players, those who tend to ignore psychological skill training, without effective stress management skills training, sometimes try to apply intervention techniques on their own, which leads to derogatory impacts (Bandura, 1997; Kobasa et al., 1982; Eubank & Gilbourne 2003; Saha et al., 2005; 2012a;2015d, e, & f; Sheard and Golby, 2010, and Westman,1990).

Since 1930, so far, several self-regulation techniques have been developed, to modulate the staggering heightened emotionality experienced by the players. Starting from training principles of mind–to–muscle and muscle–to–mind easing conditions,Jacobson's (1938) development of muscle-relaxation training in dealing with enhanced anxiety, and finally, the relaxation training concept of Benson (1975) was developed based on the yoga concept and meditational processes which were initially created by Mahesh Jogi (Benson, 1975). Eventually, this basic concept has proliferated the advancement of additional self-regulation methods like systematic desensitization, imagery training & visualization; visuomotor behaviour rehearsal (VMBR); autogenic rehearsal and others. Technological development particularly in the field of biomedical engineering finally led to the development of attempts to identify both biological (viz., HR and BP etc.) and psychophysiological (viz., EEG; EMG; PLE and Sc or EDA etc.) indices. Following the auto-sensory observations of those indices, expert psychotherapists develop self-regulation techniques

(viz., HR biofeedback; Temperature biofeedback; EEG biofeedback; EMG biofeedback and Sc biofeedback etc. VMBR training) which are tailored for sports performance enhancement (Cummings et al., 1984; Dziembowska et al., 2015; Galloway 2011; Paul and Garg, 2012; Saha et al., 2014; Saha et al., 2015d & f; Saha et al., 2018a).

The present research seeks to apply biofeedback and visuomotor behaviour rehearsal (VMBR) as specific psychological skill training. Application of biofeedback training and visuomotor behaviour rehearsal (VMBR) training in emotional regulation is then measured to determine changes in athletic performance.

1.3 Biofeedback (BF)

Biofeedback (BF) refers to the therapeutic technique which utilises electronic gazettes to evaluate and monitor and display particular physiological conditions which have concomitant psychological and psychobiological substantiated with subjective feelings of emotionality (Chattopadhyay et al., 1975 and Chattopadhyay and Biswas, 1983; Saha et al. 2014; Saha et al. 2015a, b & c). The auto-sensory systems generate and monitor some physiological cues arising out of the bodily processes that provide essential information concerning neuroendocrinological systems and enable us in optimal self-regulation (Białkowska et al., 2020; Olton & Noonberg, 1980). Biological indices provided by the devices help anindividual athlete to adapt to the physical state of feelings of negativity stemming from worry and anxiety (Patel, 1988).

Fundamentally biofeedback fills up the gap between peripheral (autonomic) neural purposes and inquisitive (which is mostly impulsive)

awareness. Upheavals in mood and high-strung emotionality put terrible deleterious impacts on the relationship between emotion and performance (Totterdell & Leach, 2001). Biofeedback interventions facilitate the regulation of mood disorders and enhance cognitive competence (Matthews, 1992) to increase determination and tenacity in performing any tasks (George & Brief, 1996). The major modalities used in the field of clinical as well as applied psychotherapy are Electromyography (EMG - BF), Peripheral Skin Temperature (PST- BF), Heart Rate Variability (HRV - BF), Skin Conductance (Sc - BF), and Electroencephalography (EEG - BF) (Condron et al., 2008).

Skin conductance (Sc) activity depends on eccrine sweat-gland activity in consequence of neurally-intervened electrical fluctuations in the skin, which is monitored by the variations in the resistance/conductance of the skin to a slight current of electricity that could be stimulated by emotion-arousing stimuli (Pflanzer, 2000). BF intervention training enhances the regulation of the parasympathetic branches of the autonomic nervous system (ANS), for instance, the heart rate (HR) drops. But variations in Sc indices on the other hand demonstrate the sympathetic nervous innervation of eccrine sweat glands, while it does not reflect any antagonistic parasympathetic innervations. Most of the sympathetic effector synapses are adrenergic or noradrenergic whereas the innervation at the effector synapse with the sweat gland is cholinergic. Hence, Sc changes do not precisely demonstrate tonic circulating levels of adrenaline and noradrenaline in the bloodstream. Emotional and cognitive states are connected with sympathetic neural activity. Thus, Sc is extensively seen as a sensitive indicator of body stimulation connected to emotion (Venables and Christie, 1980; Fowles et. al., 1981; Dawson et. al., 2000; Saha et al., 2018c;

Ismail et al., 2018).

The common procedure triggering the efficacy of biofeedback control is operative with the advancement of self-regulation or self-control that exemplifies the basicconcept of a feedback loop. This kind of loop is termed a closed system and feedback,which is only achievable in a closed system. Effective control is based upon one individual's capacity to use the feedback and divulges individual differences. This is more obvious in sports science research, as some of the players are observed as capableof decreasing their Sc indices far more easily compared to their counterparts, who might take more time to understand the instructions given to them and to follow the auto sensory processes requiring monitoring their conditions and the same time also trying to reduce their Sc indices. The other problem may pertain to the differentiallearning ability of the participants. Irrespective of these issues, learning optimal self-regulation using BF systems could be developed with practice till the feedback loop isclosed. In sport and exercise science research introduction of Sc-BF intervention techniques following exhaustive methodological considerations are scanty in number (Dustman et al., 1990; Saha et al., 2013a; Saha et al., 2015e & f, Saha et al., 2018a &c). Researchers in sport psychobiology were mostly observed to focus on the facilitative impacts of EEG Alpha (facilitates the participants to regulate their EEG activities within the range of 8 -15 Hz) & EMG biofeedback interventions on improvement in sports performance, while Sc biofeedback as psychotherapeutic interventions were largely ignored (Dustman et al., 1990; Dziembowska et al., 2015; Paul and Garg, 2012; Cummings et al., 1984; Galloway 2011; Plotkin and Rice, 1981; Saha et al., 2015e &f, Saha et al., 2018a & c).

In addition to that uncertainty concerning the number of sessions suitable for the young adult players to observe performance enhancement, as far as the present status is known, apart from the studies carried out previously in this laboratory by the present group of researchers, still, availability of research literature on the effect of biofeedback in sports performance is scarce. Further to that, the role of Scbiofeedback in improving the performance of an athlete requires special attention. Besides that, apart from research carried out in this laboratory, the introduction of Sc interventions following rigorous methodology has not yet been thoroughly studied inAsian and/or South-East Asia, especially among the Malaysian population.

Similarly, Electromyography (EMG) Biofeedback technique helps the playersand athletes in the regulation of muscle activation, motor capability and movementefficiency (Angoules et al., 2008), and reduction of muscle tension and somatic anxietyas well (Dustman et al., 1990; Dziembowska et al., 2015). In enhancing sports performance, the surface electromyogram (SEMG) uses one or more active electrodes that are placed over a target muscle, and those surface electrodes detect muscle actionpotentials from underlying skeletal muscles that initiate muscle contraction (Dustmanet al., 1990; Dziembowska et al., 2015). Therapists help the athletes to detect muscle potential, and through EMG guided isometric contractions and relaxation, athleteslearn to regulate their muscular and psychomotor ability and learn to regulate themselves in actual competitive situations (Dziembowska et al., 2015; Saha et al., 2015e & f, Saha et al., 2018a & c).

As in Sc biofeedback training, athletes' cognitively oriented engagement in self-regulation enhances the probability of successful training outcomes in

EMG Biofeedback participants' involvement, motivation and exercise compliance increasethe probability of success (Levitt et al., 1995). For track and field athletes, the introduction of EMG Biofeedback increases neuromuscular control and quadriceps strength (Croce 1986; Draper 1990; Dursun, Dursun and Kilic, 2001). Furthermore, in research using isometric exercises coupled with EMG Biofeedback, significant strength gains were evident (Lucca and Recchiuti, 1983; Waly et al., 1986; Khalil et al., 1987).

1.4 Visuo Motor Behaviour Rehearsal (VMBR)

Visuo-motor behaviour rehearsal (VMBR) is one of the most technically designed therapeutic techniques, which involves the psychological aspect of the mental configuration of the image along with the feedback from the performance of the physical skill (Lane,1980). This method has been used successfully, especially with closed motor skills, inseveral sports and ball games, such as, such as tae-kwon-do, karate (Weinberg,Seabourne, & Jackson, 1981), basketball (Gray & Fernandez, 1989; Onestak, 1997), racquetball (Gray, 1990), tennis (Noel, 1980), and cricket (Saha et al. 2012a) cross-country running, golf, track and field, gymnastics, and diving (Lohr & Scogin, 1998).Elite performers such as Martina Navratilova, Venus and Serena Williams, MichaelJordan, and Tiger Woods have rigorously used VMBR for performance enhancement (Murphy and Jowdy, 1992; Bedir and Erhan, 2021).

VMBR involves three phases: first, an initial relaxation phase to retrieve a psychological state conducive to mental imagery: second, visualizing performancethrough various imaging techniques and finally, performing the actual skill under realistic conditions (Behncke, 2004; Cece et al., 2020). Repeating this process with the intended skill during the training, real-time

feedback on performance ensues between mentally coordinating the imagery component with actual performance.., Thereby, minor changes in either the skill and/or the imagery process, can be maintained in parallel. The rationale behind VMBR is keeping mental imagery and skill performance closelyassociated in training, which should correspond to an enhancement in performance since the athlete gets ample opportunity to fine-tune both processes simultaneously.

Here the question arises that, before the application of VMBR, the perceptual-cognitive process involved in the formation of imagery within the context of performance, must be adequately regulated; otherwise, VMBR can be detrimental to the motor skill activity. Inadequate cognitive maturity (which refers to the cognitive ability to develop newer schemas of discrete skills to adapt to newer challenges) To handle the required level offlexibility in maintaining the focus of attention, simultaneously shared onto the performance of motor tasks as well as onto the method of mental imagery, would resultin further performance deterioration (Lane, 1980). Thus, the significance of utilization of VMBR becomes questionable as in the basic steps proposed by Suinn (1993) and Ungerleider (1996), athletes by and large tend to ignore the importance of relaxation training. This less emphasis on relaxation strategy may result in inadequate arousal modulation in the athletes. Further to that owing to a lack of arousal modulation and related somatised anxiety, they tend to overlook the earnestly required cognitive schema related to the motor skill and also related to performance error. These all are susceptible to result in inadequate development of imagery. Consequently, with the inadequately developed visualization of imageries and finally with the inadequate practice of imageries, instead of improvement in technique and skill enhancement under error analyses and

correction, athletes are susceptible to face miserable performance outcomes.

Therefore, this present study is intended to identify the integral processes involved in Visuomotor behaviour rehearsal (VMBR), which involves the psychological aspect of the configuration of a mental image along with feedback from the performance of the physical skill (Lane, 1980). Identification of the intricate relationshipbetween certain psychological (perceptual-cognitive and cognitive-emotional aspects); physiological and psychobiological {autonomic response habituation; sympathovagal balance and cortical potential judged by event-related potential-ERP, (i.e., stimulus or crisis-specific effective response) of the combined introduction of Sc and EMG biofeedback} determinants was done in young-adult promising players and athletes in Malaysia (Zahir et al., 2016a, b & c).

1.5 Combined Intervention

So far, this chapter focussed on discourse on conventional or contemporarily investigated ways of enhancing athletic performance. Planned intervention techniques employ electrophysiological devices to deliver integrated therapeutic assistances separately either under heightened autonomic activation or enhancement in muscular action potentials of visualization techniques. At this juncture, this study intended to design one integrated approach to intermingle components of autonomic neural regulation, along with muscular activation and visualization aspectstogether to examine the combined influence of interventions on athletic performance skills. This combined intervention was designed to facilitate emotional (autonomic arousal-specific) regulation along with the enhanced ability to use imagery of visualised cues to

the developmental schema of complex serial motor skill performances.

As far as it is known, in the Malaysian context, on developing the performance of athletes, there is no such available literature regarding the combined effect of VMBR training and Sc biofeedback training. Hence this research project intended to include another intervention plan, which would combine integrated components of VMBR training and Sc biofeedback training. This was done to observe whether the combined introduction can provide any differential benefits compared to the hypothesized outcomes of VMBR training and Sc biofeedback training alone. Based on such paradigms in this study, three groups of intervention regimes are separated. Athletes were the participants who were assumed to benefit from the information received about their physiological, psychological and psychobiological status their problems associated with dismal performances and their apprehensions for future failure. Therefore, in this present research study, three types of intervention training were used Visual Motor Behaviour Rehearsal (VMBR) Training, Biofeedback (Sc and EMG) Training and Combined Training of both Visuo Motor Behaviour Rehearsal (VMBR)Training and Biofeedback Training.

1.6 Problem Statement

a) What is the performance hindering problems faced by the athletes?

b) Whether differential intervention programs have any beneficial impacts on the regulation of performance crises in athletes?

c) Which intervention program is most effective for Malaysian young-adult athletes?

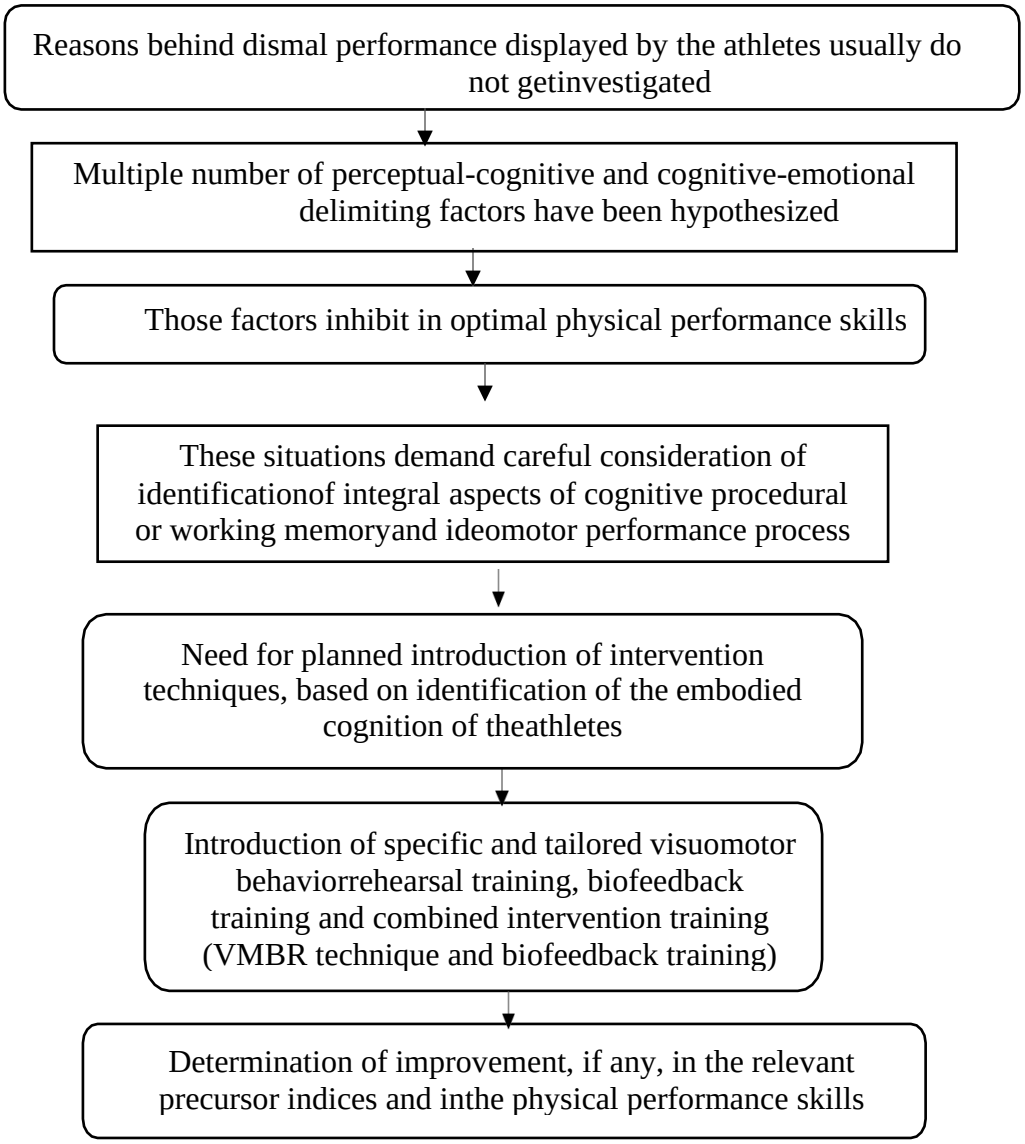
1.7 The rationale of the Study

Fewer studies were previously conducted to evaluate and assess different aspects of crises over athletic performance observed amongst young-adult promising sports performers of Malaysia. Mostly, those were conducted on recreational players, and the focus of the experimental paradigms was based separately on psychomotor crises,such as coordination disorder, reaction ability, psychological apprehensions, and/or physiological factors etc. Research paradigms related to dismal athletic performanceswere mostly carried out in the developed countries, and more so, those were carried out based on neurobiological and neurological indices, cardiovascular efficiency-related issues and/or emotional and cognitive-emotional crises as well.

At this juncture, it seems crucial to assess the aetiological issues (inherent causal factors) about commonly diagnosed deficiency in emotional adaptation, psychomotor deficits, viz., coordination problems or usual physiological (cardiovascular etc) issues evident in recreational and amateur-competitive players and athletes, which mostly do not yield any decisive conclusion. Further to that, some of the limitations, such as inner core emotionality, problems in bilateral, ipsilateral and contra-lateral visuomotor coordination, issues related to evoke-potentiality of muscles, and resultant performance lag etc. remain unanswered. Having said that, there is no research done on Malaysian promising athletes to assess the aetiological factors associated with dismal athletic performance and to recommend alternatives to enhance the quality of athletic performance. Hence, the present study has been conducted to assess the effectiveness of differentially planned interventions (VMBR and biofeedback) on the aetiological aspects (reasons behind poor

performance) associated with performance disaster evident amongst young-adult promising athletes of Kelantan and Terengganu provinces of Malaysia. In addition tothat, based on the findings of this research the present study attempts to offer a scope to design a specific and tailored intervention training protocol, which may include differential facets of both VMBR and biofeedback training regimes in combination, for the benefit of young-adult promising athletes living in these two provinces of Malaysia, who were evident with performance shortcomings.

1.8 Conceptual Framework



1.9 Objectives

This section presents the objectives of this research. To achieve the aforementioned aims this study was undertaken with one General objective and basedon that Eight Specific objectives were conceived.

1.9.1 General Objective

To study the comparative effects of psychotherapeutic intervention techniques on physiology, psychophysiology, psychomotor and physical performance parameters among athletes.

1.9.2 Specific Objectives

1. To investigate the efficacy of visuomotor behaviour rehearsal (VMBR) intervention training on physiology, psychophysiology, psychomotor and physical performance parameters among athletes.
2. To evaluate the effectiveness of biofeedback intervention technique on physiology, psychophysiology, psychomotor and physical performance parameters among athletes.
3. To compare the relative impacts of the combined introduction of visuomotor behaviour rehearsal (VMBR) technique and biofeedback training on physiology, psychophysiology, psychomotor and physical performance parameters among athletes.

1.10 Research Hypotheses

The following hypotheses were formulated to achieve the objectives.

1.10.1 Null Hypothesis (H_o)

1. Visuomotor Behaviour Rehearsal (VMBR) training does not affect differential performance indices observed among athletes.

2. Biofeedback training does not affect differential performance indices observed among athletes.
3. The combined intervention of VMBR training and Biofeedback training does not affect differential performance indices observed among athletes.

1.10.2 Alternative Hypothesis (H_A)

1. Visuomotor Behaviour Rehearsal (VMBR) training has a significant effect ondifferential performance indices observed among athletes.
2. Biofeedback training has a significant effect on differential performance indicesobserved among athletes.
3. The Combined intervention of VMBR training and Biofeedback training has asignificant effect on differential performance indices observed among athletes.

1.11 Significance of the Study

In this section, the significance of the study is described. Generally, thefindings of this research have significance in three areas. The first area is related to the performance efficacy of the athletes, evaluated by several relevant indices. The second area pertains to the evaluation of the aetiology of the problems based on the evaluation of physiological, cognitive-emotional, psychobiological, psychomotor, and physical performance skills. The third and final area, however, is the application of effective intervention techniques, which may facilitate in reduction of dismal performance andmay lead to performance excellence in athletics. Since the performance efficacy of the athletes was evaluated during the selection of candidates and the multifactorial causality

behind the performance deficiencies was analysed during the pre-intervention phase of assessment, to minimise the redundancy of the thesis, those were not detailed in the specific objective section.

Researchers dealing with psychological intervening factors behind the dismalathletic performance, often relied only on subjective self-report, which if not objectively substantiated, may contain 'response biases' and hence may be consideredas having the source of fallible data. To eradicate those problems, a projective evaluation of inner core emotionality has been conducted. The majority of the aforementioned emotional core elements never come onto the surface of day-to-day life stress, and hence, players themselves do not remain consciously aware of those internalised mostly unconscious and hidden emotional crises. These inner core disruptive emotional burdens could be revealed by projective assessments of thought-process dependent cognitive-emotionality, which could be aptly corroborated with habituation paradigm psychobiological estimation of emotional indices leading to objective and substantiated etiological evidence. The most significant methodological concern about this substantiated evaluation is that the outcomes of these analysescannot be manoeuvred and contrived and hence would be largely free from subjective biases.

Further to that, the issue of intervention techniques to be followed in the experiment warrants careful concern. Experimental studies dealing with disastrous sports performance usually consider differential relaxation and imagery techniques. In this study, instead of those VMBR and Biofeedback interventions, and combination of those was introduced. Previous research investigations carried out on visuomotor behaviour rehearsal (VMBR) and

biofeedback training have mostly been done on players who are engaged in simple and close-skill or discrete skill activities. Athletic sports events, however, comprise multiple types of activities, which may vary from simple and complex, to discrete, and serial and continuous activities as well. Thus, this entire research paradigm would intend to provide evidence of the benefits of integrated Biofeedback training and VMBR training on improvement in the psychological psychomotor and psychobiological components of emotionality and cognitive-motivational make-up of the players, which in turn will enhance the sense of self-regulation in the young players to achieve success in their performance. This study may accentuate the method of combining VMBR training and biofeedback training appropriately to improve the efficacy of the combined intervention.

Finally, this study is designed to provide evidence of the benefits of differential biofeedback and VMBR intervention techniques on physiological, psychomotor, and psychobiological parameters as well as on athletic performance, which may have a directimpact on the sports community of this nation. This study is supposed to enrich and inspire the coaches in adopting further assistance from the sports science expertsfocusing on other essential aspects of performance improvement.

1.12 Definition and Terms

- **Gross Motor Skills –** These are the fundamental motor skills, such as walking, jumping, throwing etc. These are the abilities usually acquired as part of motor development which continues throughout the developmental periods. In gross motor skills, individual needs to use large musculature (Cools et al., 2009).

- **Laterality –** This is the term, which usually refers to the individualistic preference for one lateral side of the body parts, especially the limbs (hands andlegs) over the other. This is a spontaneous selection of most human beings in selecting the lateral side to perform any motor task (Porac and Coren, 1981 Rogers et al., 2002).
- **Ipsilateral** – In this context of research, this term usually refers to one lateral sideof the body and body parts especially limbs of the same side as another structure.The right upper limb or hand, for instance, is ipsilateral to the right leg (Kinsbourne, 1978 Hickman et al.,2003).
- **Contralateral** – In this context, this term refers to the opposite lateral side of another structure. An example of the contralateral side of the body is represented by the body part of one lateral part contrary to the other side of the body. The right armand left leg are represented as contralateral to each other and vice-versa (Kinsbourne, 1978; Hickman et al.,2003 Vulliemoz et al., 2005).

  Bilateral – This term essentially refers to both sides of the body. Bilateral conceptually is discussed in the context of lateral symmetry or asymmetry. For a human being, the left and right sides of the body may be conceptually divided along the mid-line into approximate mirror images of each other (Kinsbourne, 1978; Hickman et al.,2003 Vulliemoz et al., 2005).
- **Embodied cognition –** It refers to an interactional process that explains how the perceptual and motor systems of a player interact with the external environment.There are cognitive mechanisms to select voluntary action (Koch et al., 2004).
- **Working Memory –** It is the type of temporary storage system in our

memory process. This is the short-term memory, which is also called the Rotememory, that processes the incoming sensory memory.

- **Cognitive Comprehension –** This is the cognitive ability of an individual, which pertains to visual-motor faster adaptation to the perceptual configuration of spatial and temporal irregularities. Faster and more accurate cognitive comprehension enables an individual to adapt and regulate themselves spontaneously.

1.13 Organization of the Thesis

The thesis will be presented in the following chapters:

Chapter I is the introductory chapter which gives an overall idea about different psychological; psychobiological and psychomotor aspects related to athletic performances, psychological skill training strategies along with the concept of Visuo Motor Behaviour Rehearsal (VMBR) and biofeedback etc. Along with that, this section is also prepared to provide information on the objectives and hypothesis of the present study, the rationale, and conceptual framework of the study along with its significance.

Chapter II consisted of previous research works in the field of different typesof Visuomotor Training and Composite Biofeedback Training related to improvement in motor-visual cognition and cognitive-emotional processes, mediated by modifications in Procedural Memory and Ideomotor process enhancement. The previous research reports have been presented and discussed in various sections namely 1) An overview of the study, 2) Effects of visuomotor behaviour (VMBR) training on physiological parameters; 3) Review of VMBR

training on psychobiological parameters; 4) Efficacy of VMBR training on psychomotor parameters; 5) Effectiveness of VMBR training on physical performance parameters.

6) Effects of biofeedback training on physiological parameters; 7) Efficacy of biofeedback training on psychobiological parameters; 8) Review of biofeedback training on psychomotor parameters; 9) Effectiveness of biofeedback training on physical performance parameters; 10) Efficacy of combined intervention of VMBR and biofeedback training on physiological parameters; 11) Review of combinedintervention of VMBR and biofeedback training on psychobiological parameters; 12)Effects of combined intervention of VMBR and biofeedback training on psychomotor parameters; and, 13) Effectiveness of combined intervention of VMBR and biofeedback training on physical performance parameters. Here, one issue has been considered noteworthy to be mentioned, that the description of the studies included in the review is based on chronological order starting from the latest research. The pertinent literature will be discussed in detail and those of less relevance have been omitted due to the space constraints and this does not underrate the significance of those studies.

Chapter III is the methodology chapter. This chapter describes pertinent information about the type and number of participants, and their inclusion and exclusion criteria for volunteering in this study. In the next section of this chapter, detailed information on the description of the materials or devices used and the methods employed in obtaining the data are detailed. Further to that, the studyprocedure has been presented in detail, which included the Flow-Chart and Gantt Chartof the study. Thereafter, details of the various intervention regimes, which were used in this present study and the differential protocols for those

intervention training regimes were also detailed in this section. This section also included the step-by-step procedure of collection of data, in different phases of evaluation, viz., pre-intervention; mid-term evaluation; post-intervention and post-follow-up evaluation were also presented in detail. Apart from that, details on the introduction of the various interventionregimes (following differential protocols) were also presented. Finally, information onthe different statistical analyses that were done to treat the obtained data was also brieflymentioned.

Chapter IV outlines the results and analysis of the results obtained from the present study. In this chapter, information on three statistical outcomes viz., 1) information about the descriptive analyses of the data, 2) reports on Repeated Measure of ANOVA, and 3) outcomes of the Multiple Linear Regression analyses were presented.

Chapter V is the discussion chapter where the findings obtained on Visuomotor behaviour rehearsal (VMBR), biofeedback training and combined intervention training of (VMBR), and biofeedback training have been discussed separately followed by a synthesis of all these findings in comparison with controls and general discussion of the same thereupon.

Chapter VI is the last chapter of this thesis, in which general conclusions obtained from the present investigation are put forward and the limitations of the study

are also mentioned. Implications of the present study and suggestions for furtherresearch are also given here.

Appendices included:

A. Ethical clearance letter from Universiti Sains Malaysia (USM) Ethics