Chapter 2

Review of Literature
2.1 Shooting Sports

The first official ban on "stimulating substances" by a sporting organization was introduced by the International Amateur Athletic Federation in 1928. Using drugs to enhance performance in sport is not new, but it is becoming more effective. Yet despite the health risks, the regulating bodies' attempts to eliminate drugs from sport, the use of illegal substances is widely known to be rife. Much of the writing on the use of drugs in sport is focused on this kind of anecdotal evidence. There is very little rigorous, objective evidence because the athletes are doing something that is a taboo, illegal, and sometimes highly dangerous. The anecdotal picture tells us that our attempts to eliminate drugs from sports have failed. The World Anti-Doping Agency code declares a drug illegal if it is performance enhancing, if it is a health risk, or if it violates the "spirit of sport" (WADA, 2003).

The welfare of the athlete must be our primary concern. If a drug does not expose an athlete to excessive risk, we should allow it even if it enhances performance. In 1998, the president of the International Olympic Committee, Juan-Antonio Samaranch, suggested that athletes be allowed to use non-harmful performance enhancing drugs. Performance enhancement is not against the spirit of sport; it is the spirit of sport. To choose to be better is to be human. Athletes should be given this choice. Their welfare should be paramount.

Shooting is suitable for the investigation of brain correlates of attention as;

(i) It demands highly focused attention.

(ii) Can be used as "real world" task.

(iii) As there are professional sportsmen who are experts in the task. (Loze et al., 2001) or archers (Salazar. W et al., 1990).

(iv) Finally, it has been demonstrated that during shooting focus and concentration are better in experts (Tremayne and Barry, 2001).
Based on the above factors our study also included shooters as the right choice of subject population for this kind of study, the presented study clearly underlines that the ability to focus attention is a major factor for shooting.

Marianne, (2009) focused on examining the relation of preparatory physiological activity to skilled sport performance, and investigating the psychological relevance of this activity. For this purpose, a varying combination of physiological variables, including brain slow potentials (SPs), heart rate, respiration, EMG, and trigger movement, were recorded during the aiming phase of actual shooting or modified shooting task. These physiological measures were collected on right-handed male competitive sharpshooters and untrained novice subjects in four separate experiments. In all, the study demonstrated that the psychophysiological approach provides a useful tool for achieving an understanding of the covert processes involved in sport performance. More specifically, it can help us to gain a better insight into rapidly occurring processes, which may not be subject to verbalization or observation, but which contribute to the determinants of a successful performance.

The present study is focused on examining the relation of physiological response to skilled sport performance, and investigating the relevance of relaxation therapies in pre-competition anxiety. For this purpose, a varying combination of physiological variables, including Heart Rate Variability (HRV) and Salivary Cortisol (SC) were recorded during the training and pre-competition phase of actual shooting. The term stress was first applied in a biological context by the endocrinologist Hans Selye in the 1930s. He later broadened and popularized the concept to include inappropriate physiological response to any demand. In his usage stress refers to a condition and stressor to the stimulus causing it. Physiologists define
stress as how the body reacts to a stressor, real or imagined a stimulus that causes stress. Acute stressors affect an organism in the short term; chronic stressors over the longer term.

2.1.1 Response to Stress

**Alarm** is the first stage. When the threat or stressor is identified or realized, the body's stress response is a state of alarm. During this stage adrenaline will be produced in order to bring about the fight-or-flight response. There is also some activation of the HPA axis, producing cortisol.

**Resistance** is the second stage. If the stressor persists, it becomes necessary to attempt some means of coping with the stress. Although the body begins to try to adapt to the strains or demands of the environment, the body cannot keep this up indefinitely, so its resources are gradually depleted (Figure.2.1).

**Exhaustion** is the third and final stage in the GAS model. At this point, all of the body's resources are eventually depleted and the body is unable to maintain normal function. The initial autonomic nervous system symptoms may reappear (sweating, raised heart rate etc.). If stage three is extended, long term damage may result as the body, and the immune system is exhausted and function is impaired resulting in decompensation (Selye, 1936).

2.1.2 Eustress and Distress

Selye (1975), categorized stress into eustress and distress. Where stress enhances function (physical or mental, such as through strength training or challenging work) it may be considered eustress. Persistent stress that is not resolved through coping or adaptation, deemed distress, may lead to anxiety or withdrawal (depression) behaviour.
2.2 Pre-Competition Stress or Anxiety in Sports

Anxiety consists of feelings of apprehension and fear in anticipation of an unknown and unfamiliar situation. It is more specifically characterized by subjective, consciously perceived feelings of threat, nervousness, and tension accompanied by autonomic nervous system arousal. Behaviors associated with anxiety include restlessness, trembling, shortness of breath, fearful facial expressions, muscular tension, and fatigue. Anxiety is not always transient; it often affects the subjects psychologically and physiologically.

Competition, implying that one or more individuals carry out some actions directed toward achieving a goal by confronting another individual or group of the same species motivated by the same goal, is a quite frequent situation in human communities or groups at different levels of "civilized" development. Competition plays an important social role, not only to get primary reinforcements such as food, but also to obtain other secondary resources, such as employment, promotion and admission etc. These secondary resources ultimately make it possible to get the best primary resources. Human competition is common, although the ways of interaction may differ from the more primitive organized groups to the more advanced indus-
trialized societies, from direct aggression and violent acts to the use of subtle or Machiavellian strategies. Advancing in the understanding of human competition, its cognitive antecedents, its psychobiological response patterns and its more basic neurobiological mechanisms, will allow us to increase understanding about the basis of individual differences, as a way of improving and addressing their potentially negative effects, thus preventing this allostatic overload.

In sports anxiety, frustration, or anger (related or unrelated to athletic participation) experienced prior to practice may lead to thoughts such as, "I'm too stressed to practice," which in turn results in the decision to skip practice. This would be an example of rule-governed behavior, as the avoidant behavior is directly governed by the cognitive response to the emotion of anxiety (a personal rule established by the individual) and not a choice of action consistent with the valued goal of improving performance, engaging in athletic competition, and enjoying the process of athletic participation.

Pre-competition anxiety is a widely prevalent condition that exists among athletes of all levels and within every sport. Its relationship to performance has been studied both in and out of the sport context through test anxiety research (Liebert and Morris, 1967) and anxiety research with athletes (Chamberlain and Hale, 2007; Kais and Raudsepp, 2005; Swain and Jones, 1996). Despite the large body of research on pre-competition anxiety, our understanding of its relationship to performance remains elusive.

According to Salvador and Costa (2009), there are two extreme coping strategies (active or proactive vs. passive or reactive). The active strategy is characterized at the behavioral level by "fight or flight" and at the physiological level by high basal levels of testosterone (T) and noradrenalin and a high reactivity of Sympathetic Nervous system (SNS), represented by the reactivity of the plasma catecholamines and the Blood Pressure (BP). The passive strategy is
characterized by scarce social activity and even immobility and at the physiological level by a parasympathetic response, greater Hypothalamus Pituitary Axis (HPA) response and reduced levels of T.

Figure 2.2: Model of neuroendocrine and mood responses to a competitive situation (Salvador and Costa, 2009)

In competitive situations, victory would lead to increases in testosterone (T), whereas defeat would produce decreases, in such a way that in the winners their dominance and tendency to participate in future social encounters would increase; on the contrary, the losers would develop submissive signs, with a diminished tendency to fight (Figure.2.2).

The relevance of several characteristics of a sports context to study this subject in humans: no pre-established outcome, merit as main criterion of success, and attractiveness derived from the equality of opportunities. In addition, competition is the central focus of sports, it has a limited duration, and its outcome is unambiguous: immediate with clear consequences in
the ranking. There is an apparent relationship between performance and reward. All these aspects do not appear as clearly in other contexts of human activity, in which there is, however, an important degree of competitiveness. Based on these factors, the majority of research on this topic has been carried out in the sports context.

2.2.1 Types of Stress or Anxiety

Spielberger (1966) postulated that anxiety can take two forms: state anxiety or trait anxiety. State anxiety refers to an emotional state consisting of fear or apprehension while trait anxiety refers to a predisposition to perceive situations as potentially threatening and respond with manifestations of state anxiety. State anxiety is "characterised by subjective, consciously perceived feelings of apprehension and tension, accompanied by or associated with activation or arousal of the autonomic nervous system" while trait anxiety is an "acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively non dangerous circumstances as threatening and to respond to these with state anxiety reactions disproportionate in intensity to the magnitude of the objective danger". Athletes who are predisposed to higher levels of trait anxiety will perceive sport competition environments as being more threatening than they may actually be and respond with greater state anxiety responses.

Trait anxiety in sport can be manifested in many ways. Sarason (1984) indicated the existence of two distinct dimensions of trait anxiety: cognitive anxiety and somatic anxiety. Cognitive anxiety is predominantly psychological in nature and is characterised by feelings of worry about outcomes and the use of negative mental imagery. Conversely, somatic anxiety is physiological in nature and includes increases in heart rate and increased perspiration. An excellent review of the relationship among forms of anxiety has been published by Smith et al., (1998).
The relationship between pre-competition anxiety, self-confidence, and athletic performance is a prevalent topic in the sport psychology literature. For decades, researchers have attempted to understand the predictive value of cognitive anxiety, somatic anxiety, and self-confidence on performance. Investigators initially focused on the 'intensity' of these constructs before incorporating the concept of 'direction'. The aforementioned research has been conducted within a variety of sports, including basketball, a little in shooting.

### 2.2.2 Stress or Anxiety prevalence

The manifestations of anxiety have been shown to have numerous negative effects on performance. For example, Yoo (1996) indicated that anxiety is an influential variable in reducing cue-utilization and attentional processes of motor-task performance. These findings are supported by Lee et al. (1992) and (Graham-Jones and Cale, 1989) who also found that forms of anxiety reduced elements of motor performance (i.e., reaction time and percepto-motor speed respectively).

(Kenow and Williams, 1992), reported anxiety in athletes may also affect the relationships between athlete and coach. Study indicated that anxiety in athletes influences their evaluation of coaching behaviours. Athletes who were more anxious and less confident were found to evaluate coaching behaviours more negatively. The above studies clearly indicate the relationships between anxiety and both sport performance and athlete perceptions.

The mild and high levels of anxiety that were found can be compared to anxiety levels experienced by students about to enter a written examination (Houtman and Bakker, 1989), novice teachers at the start of their first lecture (Houtman, 1990), or athletes just prior to competition (Joseph et al., 2003). As an example, mean anxiety scores reported by individual
and team athletes were 5.5 and 4.2, respectively. Similar means (generally ranging between 4 and 5) were found for athletes prior to competition by (Krane, 1994).

Furthermore past research has demonstrated correlations between cognitive anxiety intensity, somatic anxiety intensity, and self-confidence (Martens et al., 1990; Swain and Jones, 1996). In a study examining basketball and volleyball players, a significant negative correlation emerged between intensity and direction of both anxiety types (Kais and Raudsepp, 2005).

Jones and Swain, (1995) suggested that athletes in explosive sports perceive anxiety as facilitative to performance, whereas athletes involved in sports requiring fine motor skills and lasting longer may perceive anxiety as debilitating to performance. The complex nature of basketball, therefore, may contribute to the lack of clear relationships between anxiety, self-confidence, and performance. Specifically, as cognitive and somatic anxiety increased in intensity, self-confidence decreased. These findings indicate that negative thoughts such as worry or fear, as well as the bodily responses to anxiety, impair self confidence.

Mark and Toto (2007), had done a study to determine athletes’ sources of acute stress (SAS) perceived as highly intense and experienced during the competitive event, their respective coping styles (CS) for two different (highly intense) stress sources (SAS), the relationship between the acute stressors and their CS (approach and avoidance coping in cognitive and behavioral forms), results showed that general CS was significantly related to general sources of acute stress. Structural equation models indicated that the athletes’ coping styles were positively related to their respective acute stressors category. The results of the analyses indicated valid and reliable relationships between CS and SAS among the athletes. The results indicated that athletes who experienced intense coach-related acute stress were more likely to use primarily an approach-behavior CS followed by the other CS.
A recent meta-analysis examined the effects of competitive anxiety and self-confidence on athletic performance (Craft et al., 2003). From this analysis, the authors concluded that a weak relationship appears to exist between competitive anxiety, self-confidence, and athletic performance. Some studies are showing relationship between personality traits and anxiety response (trait anxiety).

Stephen et al., (2009) findings also reported that, prior to competing, sport performers encounter more stressors pertinent to performance than those emanating from the organization, these observations highlight that all the demands faced by athletes should be considered when preparing and implementing interventions to manage competition stress.

Traditionally, researchers focused exclusively on anxiety intensity as a predictor of performance. Reduction in “negative” affective states such as anxiety, and/or increases in self-confidence, does not consistently result in significant increases in athletic performance (Burton, 1989). Due to contradictory results regarding the predictive value of anxiety intensity on performance, however, (Jones and Swain, 1992) emphasized the impact that interpretation of anxiety may have on performance (i.e., an athlete’s perception of anxiety as facilitative or debilitating to performance). Through implementing (Jones and Swain, 1992) subscale, researchers have demonstrated that a directional component of anxiety, or a determination of the perception of anxiety as debilitating or facilitative to performance, is generally a greater predictor of performance than intensity (Kais and Raudsepp, 2004; Swain and Jones, 1996).

Several researchers have used questionnaires to study the effect of each anxiety construct on athletic performance, but have produced contradictory results (Chamberlain and Hale, 2007; Edwards and Hardy, 1996; Parfitt and Pates, 1999; Taylor, 1987). As (Gould et al., 1987) observed, the contradictory results may be attributed to inconsistencies among research methodologies. For example, some researchers have employed subjective measures of
performance such as self-reports (Edwards and Hardy, 1996), whereas others have used outcome-based (i.e., win/loss) performance measures (Gould et al., 1984). Furthermore, results may be sport-specific, in responding to these issues, Sonstroem and Bernardo, (1982) suggested the use of comprehensive and objective performance measurements within a single sport.

Majority of all these studies measured the anxiety by subjective questionnaires, so it is indeed to establish by physiological means. Based on these evidences our study is concentrated more on physiological markers rather than subjective measures.

2.2.3 Stress, Physiological Aspects

Stress/anxiety produces upper beta brain waves for reaction. Blood flow decreases to the cerebral cortex especially to the frontal lobes and non-dominant hemisphere causing learning and memory to decrease. Stress overwhelms the autonomic nervous system causing incoherence and emotional imbalance. This stress results in increased internal "noise" in the brain disrupting information processing, overloading attention, cognition, learning, working memory and emotional stability circuits (Ashcraft and Krause, 2007; Chen et al., 2008). The amygdale stimulates the hypothalamus, which in turn projects a nerve impulse to the sympathetic nervous system at the base of the brain stem, on a mainly subconscious level (Hannaford, 2002). This action stimulates the adrenal glands to produce adrenaline, preparing the body for a fight or flight response. Simultaneously, the hypothalamus also produces a corticotrophin-releasing factor (CRF). The corticotrophin-releasing factor stimulates the pituitary gland to produce adrenocorticotropic hormone (ACTH), which stimulates the adrenal glands to produce Cortisol. Cortisol provides energy to the muscles but also decreases memory and learning (Hannaford, 2005). Adrenaline increases heart rate variability (HRV) patterns, speeds up respiration, tenses the muscles thereby decreasing the flow of cerebral spinal fluid, the knees may lock-unbalancing
the body, digestion is stopped or slowed, pupils dilate, and vision is alerted to the periphery. The literature describes this severe level of distress, as found in high Trait Anxiety. The level of anxiety automatically narrows perception restricting the focus of attention (Ashcraft and Krause, 2007; Bruner et al., 2002; Curry et al., 2006; Fredrickson and Branigan, 2005; Most et al., 2005; Ramachandran and Rogers-Ramachandran, 2005; S. B. Sarason et al., 1964; Simons and Chabris, 1999).

2.2.4 Pre-Competition Anxiety on Athletic Performance

Allostasis is a fundamental process through which organisms actively adjust to both predictable and unpredictable events (McEwen and Wingfield, 2003). It is complemented with other concepts, such as the "allostatic load", which can be described as the cumulative impairment ("wear and tear") derived from the frequent or inefficiently managed activation of the mediators of the allostasis (hormones, neurotransmitters, cytokines, etc.). Complementarily, "allostatic overload" appears as a state in which serious pathophysiology can occur if it is chronically high. Based on the balance between energy input and expenditure, (McEwen and Wingfield, 2003) proposed two types of allostatic overload. Type-1 allostatic overload occurs when energy demand exceeds supply, resulting in the activation of the emergency life history stage; when the stressor passes, the normal life cycle can be resumed. Type-2 allostatic overload begins when there is sufficient or even an excess of energy consumption accompanied by social conflicts and other types of social dysfunctions. The second type is the case of human society and animals in captivity in certain situations and does not trigger an escape response. This implies that a specific environmental condition may differentially affect allostatic loads in different individuals.

2.2.5 Theories behind Stress or Anxiety
Over the past few decades, sports psychology researchers have examined the common issue of pre-competition anxiety and its effect on athletic performance. An emerging theory that provides a comprehensive account of the mechanisms behind the effects of anxiety on performance, including the proposed changes in attention, is attentional control theory, which has recently been developed on the basis of processing efficiency theory. Although attentional control theory and processing efficiency theory are claimed to have most relevance to cognitive performance, several studies have provided empirical support for the processing efficiency theory with respect to perceptual-motor tasks (Nieuwenhuys et al., 2008).

According to processing efficiency theory there are two kinds of processes in response to anxiety. First, anxiety may lead to worry about task performance, which will "preempt some of the processing and storage resources of the working memory system", possibly leading to hampered performance. Second, although worry may tax working memory processing and capacity, the adverse effects of anxiety may be compensated for by a second stream of processes involving increased on-task effort and activities to improve performance. In support of this proposal, studies investigating perceptual-motor performance have found that increases in state anxiety are often accompanied by a concomitant increase in perceived effort (Oudejans and Nieuwenhuys, 2009).

Jones (1995), Drive theory, originally proposed by (Hull, 1943) and later modified by (Spence and Spence, 1966), hypothesizes that increases in drive (often used synonymously with arousal, stress and anxiety) are associated with a linear increase or decrease in performance, depending upon the dominant response. In the early stages of learning, the dominant response is incorrect and increases in arousal will impair performance; later in learning, when the dominant response is correct, increases in arousal will enhance performance.
Svebak (1991), had discussed two types of stress in reversal theory: 'tension-stress' occurs when there is a discrepancy between preferred and actual level of arousal; and 'effort-stress' occurs as a consequence of attempting to reduce tension-stress. It should be clear that the intervention options for performance enhancement are not merely concerned with increasing or decreasing arousal levels. Instead, they include inducing reversals from paratelic to telic in the case of tension-stress caused by low arousal, and from telic to paratelic when tension-stress is caused by high arousal. Kerr, 1987 has suggested that it is possible for sports performers to induce the necessary reversals via a cognitive restructuring or imagery strategy.

Yerkes and Dodson (1908), demonstrated an inverted-U relationship between arousal and performance whereupon increases in arousal aid performance to a point, after which further increases debilitate performance. In recent decades, however, researchers have established a multidimensional rather than unidimensional construct of pre-competition anxiety (Martens et al., 1990). Cognitive anxiety pertains to negative thoughts (i.e., worry and fear) and somatic anxiety refers to perceptions of the physiological (i.e., tension and nervousness) response to anxiety. (Martens et al. 1990) posited that: (1) cognitive anxiety intensity will exhibit a negative linear relationship with performance; (2) somatic anxiety intensity will exhibit a curvilinear relationship with performance; and (3) self-confidence will exhibit a positive linear relationship with performance.

(Turner, 1993), female and male members of the Indiana University track and field team were evaluated for trait, baseline state, and recalled best state anxiety using the State-Trait Anxiety Inventory (STAI). Actual pre-competition anxiety was assessed one hour prior to competition in the four meets and compared to predicted anxiety via correlational analysis. Results revealed that subjects possessing optimal anxiety as defined by any of the inverted-U classifications (16 of 16 tests) did not perform better than their counterparts outside of optimal.
In terms of self-confidence and performance, the Multidimensional Anxiety Theory (MAT) (Martens et al., 1990) states that self-confidence exhibits a positive correlation with athletic performance. Other researchers have found similar results in the sports of field hockey (Maynard and Cotton, 1993) and bowling (Jerome and Williams, 2000). (Gould et al., 1987) found that self-confidence actually exhibited a negative linear relationship with performance.

There still exist inconsistencies among the literature. (Swain and Jones, 1996) found that anxiety and self-confidence direction affect basketball performance contrary to that predicted by the Multi-dimensional Anxiety Theory (MAT) (Martens et al., 1990). (Kais and Raudsepp, 2005) demonstrated that only cognitive anxiety intensity positively affected basketball performance. (Maynard and Cotton, 1993) used undergraduate, male field hockey players while (Jerome and Williams, 2000) studied male and female, semi-professional and recreational bowlers. The varying results may be due to the different methodologies used by the aforementioned researchers.

Researchers have studied anxiety and performance across several sports and various levels of experience. Studies with triathletes (Lane et al., 1995), beach volleyball players (Kais and Raudsepp, 2004), indicated no significant correlation between anxiety intensity and athletic performance.

Gould et al., (1987) supported the aforementioned relationship in regards to cognitive anxiety, but found somatic anxiety to exhibit a curvilinear relationship with pistol shooting performance.

Alternately, (Maynard and Howe, 1987) determined that rugby performance decreased as somatic anxiety increased, but only for those who played worse than normal. Anxiety direction seems to be more strongly correlated with athletic performance than anxiety intensity.
Julien et al., (2009), examined parental influence on athletes' pre-competitive anxiety in basketball and tennis players before an official competition. Analysis of variance indicated that the presence of both parents was associated with higher pre-competitive anxiety for all participants, except male tennis players. The absence of both parents did not result in less anxiety. This study supports the presence of pre-competitive anxiety in sports arena especially in children and adolescents.

Kais and Raudsepp, (2004) studied beach volleyball players and found a positive linear correlation between both cognitive and somatic anxiety direction and performance. Although there seem to be differences between sports, there exists a paucity of research within each sport.

The researchers found a negative correlation between anxiety intensity, as measured by the CSAI-2, and basketball performance. Due to the large range of task complexity within the game of basketball, Parfitt and Pates, (1999) reported the effect of cognitive and somatic anxiety on two different components of basketball performance. As hypothesized, somatic anxiety significantly predicted performance involving anaerobic power (vertical jump height). Although researchers have established that anxiety 'intensity' is moderately predictive of basketball performance, they have also demonstrated that the interpretation of anxiety as facilitative or debilitative ('direction') is significantly more predictive of overall basketball performance.

Furthermore, researchers have shown statistically significant relationships between self-confidence and the two anxieties constructs. Self-confidence was negatively correlated with cognitive and somatic anxiety intensity and positively correlated with cognitive and somatic anxiety direction (Kais and Raudsepp, 2005). Our understanding of the relationship between self-confidence and performance remains unclear as researchers have found incongruous results. The inconsistent findings indicate that the effect of self-confidence on athletic performance may vary based on the nature of the task. For example, results may vary for team vs. individually
performed sports, endurance vs. sprint sports, or artistic sports (i.e., gymnastics, figure skating) vs. sports in which artistry is not judged.

Despite the several theories that have emerged as a result of decades of anxiety performance research, recent studies seem to question the true nature of their relationship. Anxiety-performance relationship across multiple sports may provide a general understanding of this issue, but deeper investigation into the relationship within each sport is likely necessary to thoroughly comprehend this phenomenon.

2.2.6 Experienced Vs Novice Response to Stress or Anxiety

Annett and Kay (1956), Studies have drawn a distinction between experts and novices by showing that a skilled person has more time to act. (Mononen et al., 2003a), Elite shooters are more capable of keeping their rifles more stable during the aiming period compared to novices as their body oscillations are much smaller.

McPherson (1993), Research comparing experts and novices points to the fact that experts are able to search a visual display faster and are also able to extract the necessary information to execute the task. Rose and Christina, (1990) Differences in perceptual and cognitive characteristics have been used to differentiate expert (or elite) and novice (or sub-elite) performers. Shooting eye contrast sensitivity in males and females as well as focus and concentration for males may be the most critical components relative to shooting performance.

In search for an explanation for choking under pressure-induced anxiety, it has been proposed that anxiety is accompanied by changes in attention. On the one hand, these changes may involve changes to internal processes characterized by elevated levels of self-consciousness often in the form of more worries and self-focused attention (Wilson and Smith, 2007).

On the other hand, the changes may concern visual attention, with less efficient gaze behaviour manifesting itself in higher search rates and shorter quiet eye durations. These
attentional changes may distract from primary task execution, leading to hampered performance (Oudejans and Nieuwenhuys, 2009). Studies have proved that, experienced athletes have less anxiety during the competition than the novice. This is showing the correlation that the capacity to control the anxiety in experienced athletes is higher thus ultimately enhancing sports performance.

The results of the previous studies clearly underline that the ability to focus attention is a major factor for shooting. While novices are unable to focus attention exactly to the triggering time point, experts are very well able to do so. Novices tend to remain at a stable amount of focused attention while experts are more likely to control the time point of shooting.

To gain a more complete understanding of the anxiety-performance relationship, researchers have recently included an analysis of physiological stress markers (Filaire et al., 2007; Haneishi et al. 2007) These markers (i.e., Cortisol and heart rate) may serve to confirm the intensity of physiological arousal because, as (Ward and Cox, 2004) suggested, "Using the psychological construct of somatic anxiety as a substitute for physiological arousal is problematic".

Perhaps findings have been equivocal due to the broad range of methodological designs. For example, performance measures have been taken in a variety of ways: some researchers opted for the use of subjective measures of performance (Edwards and Hardy, 1996) while others evaluated performance based on statistics (Kais and Raudsepp, 2004; Sonstroem and Bernardo, 1982). Although sport-specific research may be more valuable than multi-sport studies due to the variety of tasks in each sport (Martens et al., 1990).

2.3 Relaxation Therapies
Coaches and sport psychology consultants can use a segment of practice to teach the athletes ways to reduce anxiety (e.g., meditation, deep breathing) and how they can implement these techniques prior to games is still not scientific based. Furthermore, coaches should occasionally call for anxiety-producing drills during practice to properly prepare the athletes to deal with these situations in games. Health care professionals are beginning to treat not only the patient’s medical condition or diagnosis, but the patient’s state of mind as well.

Historically, efforts to enhance athletic performance have been most clearly related to the development of social cognitive theory (Bandura, 1977) and early skills training models of cognitive-behavioral interventions. From this perspective, athletes develop and utilize psychological (mental) skills such as goal setting, imagery/mental rehearsal, arousal control, self-talk, and precompetitive routines as vehicles to aid in the development of self-control of internal processes such as thoughts, emotions, and bodily sensations, in an attempt to create the ideal performance state (Hardy et al., 1996).

Applied sport psychology, in its efforts to enhance the competitive performance of athletes, has traditionally utilized cognitive behavioral methods and techniques with an emphasis on developing self-control of internal states, commonly referred to as psychological skills training (Whelan et al., 1991). In contrast, behavioral theorists in professional psychology have recently begun to advocate and demonstrate empirical support for interventions that emphasize acceptance, rather than direct change, suppression, or control, of cognitive and affective experiences (Roemer and Orsillo, 2002).

Psychological skills training (PST) procedures, while concurrently commenting on the inconsistent and inconclusive empirical support for such approaches. In addition, questions may be raised regarding the theoretical assumptions that are at the foundation of these procedures. Fundamental to PST is the long-held assumption that reduction of negative emotions and bodily
states, and associated increases in positive cognitions and confidence levels, are directly related to an "ideal performance state," which in turn is directly related to optimal athletic performance (Hardy et al., 1996). Based primarily on correlational studies, practitioners of sport psychology have long accepted the notion that more successful performers are less anxious, more confident, and experience fewer negative thoughts. What follows from this theoretical position is the related assumption that interventions targeting the enhancement of athletic performance focus on supplanting negative thoughts with positive ones and reducing or controlling negative affective states (Hardy et al., 1996).

Few studies have examined the relationship between the frequency of practicing Guided Imagery (GI) and its outcome. Some studies have indicated that the frequency of practicing GI has no effect on reducing blood pressure or depression scores. The relationship between the duration of practicing GI daily and psychophysiological measures remains unclear, due to a lack of research in this area. Results suggest that subjects who had a longer history of practicing a GI program at home once daily for 20 min showed higher baseline scores of their positive mood on MMS, image vividness on QMI and general health, and lower baseline scores of their negative mood on MMS and general stress than subjects who had shorter or no history of GI at home.

Relaxation exercises offer a means to reduce the physiological and psychological reactions to stress. Current achievement-based, demanding and high-tempo society has incurred increased risks and vulnerability for stress related chronic pain and other illnesses. A multitude of techniques for relaxation and stress-reduction are described, e.g. flotation-REST, Tai Chi Chuan, meditation and yoga. The different relaxation techniques often lead to specific psychological and physiological changes termed the 'relaxation response' (RR). The RR is identified as the physiological opposite of the stress or 'fight-or-flight response'. The RR is
associated with instantly occurring physiological changes that include reduced sympathetic nervous system activity, reduced metabolism, lowered heart rate, reduced blood pressure, and decreased respiratory rate. At the psychological level, individuals typically report that RR techniques result in genuine rest, recovery from fatigue, better sleep quality, as well as an increased sense of control and efficacy in stressful situations.

To help clarify the pre-competition anxiety and performance relationship, researchers have begun to introduce a psychophysiological approach. Specifically, researchers have measured both psychological (i.e., self-report inventories) and physiological (i.e., heart rate, Cortisol) anxiety markers in various situations. Some researchers have also compared Cortisol concentration and psychological anxiety scores before competition. Although the research is limited, there now exists a solid platform from which to examine knowledge of this issue.

Meditation is a specific consciousness state in which deep relaxation and increased internalized attention coexist. There have been various neurophysiological studies on meditation. However, the music therapy and meditation effects individually and its combination in pre-competition stress and its physiological effects in sports have not been adequately studied.

### 2.4 Music as Therapy

Use of sound for healing dates from man’s earliest records. From the early 1900s, pioneer researchers have examined the effect of music on human physiology. During the past few decades, increasing interest in the therapeutic effects of music on health has promoted studies of the effect of music on pain, anxiety, and mood in a variety of healthy people and patient populations, using physiologic measures as well as participant reports. In most of these studies, listening to relaxing music resulted in decreased perception of pain, lower blood pressure and heart rate, less anxiety in response to stressful procedures, and lower scores on various anxiety
scales. The success of music in providing comfort and reducing anxiety has resulted in the commercial production of music tapes made especially to promote a particular mood or state. These tapes have become popular as a self-help method.

The sport psychology literature contains an abundance of anecdotal and qualitative evidence suggesting that optimal performance depends, in part, on the intensity and experience of a mental state described as flow. The main proponent of flow explained that it represents an optimal psychological state that is characterised by a near perfect match between the challenge imposed by a particular situation and the skills that the performer brings to it. During flow, one is totally absorbed in the task leading to optimal physical and mental functioning. It is seen as an altered state of awareness in which one feels deeply involved in the activity and where mind and body operate harmoniously. Flow represents the apotheosis of intrinsic motivation; ostensibly, the activity is enjoyable in its own right and not engaged in for the derivation of external rewards and benefits. The development of the FSS enabled to examine the relationship between flow and the motivational qualities of music. In their study, the results revealed a significant association between ratings of the motivational qualities of music and perceptions of flow. The influence of music in the promotion of flow state in an exercise context has been the subject of recent research interest, with the prevailing view being that carefully selected music may promote flow. Careful selection of music entails consideration of participants' ages, socio-cultural background, and preferences as well as the task that the music is intended to accompany. One mechanism through which music may impact on flow is by enhancing pre-performance mood. Indeed, in a recent review, presented a strong case for the mood-enhancing effects of music in a sport context (Vlachopoulos et al., 2000).
Karageorghis et al. (1996), assessed the effects of asynchronous (background) motivational music and oudeterous (defined as neither motivational nor demotivational) music on perceptions of flow during an endurance shuttle running task. Significantly, this was the first study that controlled for the possible confound of variability in pre-performance mood (Jackson and Roberts, 1992).

The components of motivational music (Karageorghis et al., 1999), more specifically, the extra-musical associations that players had with their self-selected music were expected to rouse them towards optimal psychological state and superior performance. These results suggest that music may be an effective tool for improving performance in netball players. Studies support previous research that found music to be an effective tool for improving athletic performance (Copeland and Franks, 1991; Ferguson et al., 1994; Karageorghis et al., 1996).

The qualitative data suggest that music not only improves performance and increases feelings associated with flow but may also be used to help athletes cope with competition anxiety and to improve their self-confidence.

Evidence for the positive effect of music on performance can be gauged from a number of sources. For example, Ferguson et al., (1994) demonstrated that karateka (karate players) attained superior performances with the use of asynchronous (background) music during performance. Likewise, performance improvements were observed in treadmill running tasks under conditions of asynchronous music (Copeland and Franks, 1991). Additionally, (Anshel and Marisi, 1978) provided evidence for improved work output under conditions in which music was synchronised with physical tasks (synchronous music). Studies that have investigated the stimulative or energising effects of music have also noted benefits in the performance of physical
tasks (Karageorghis et al., 1996). Further, Jackson and Roberts, (1992) reported that pre-performance mood was a key antecedent of flow among elite figure skaters.

In summary, the previous findings suggest that a music intervention may enhance performance and trigger emotions and cognitions associated with flow. Further study is required to enable music-related interventions to be accepted by the sports science community on the basis of strong empirical evidence. Specifically, now that the benefits of music have been repeatedly demonstrated in laboratory settings, more ecologically valid and group-based research methods would serve to bolster the knowledge base.

Before discussing the application of music therapy, it is important to note that music is "acoustically different from all other sounds" (Standley, 2003a, 2003b) because it is both "sound and silence expressively organized in time". Noise, on the other hand, has no fixed pitch (Standley, 2003a, 2003b). Music and noise are processed differently by the brain; noise is irregular and unanticipated, which creates stress. Conversely, music is organized and predictable, functioning to soothe. Therefore, the unique properties of music can be applied therapeutically by trained music therapists. Music therapy involves the use of evidenced-based music techniques by a trained, credentialed music therapist to achieve behavioral change in an individual (Standley, 2003a, 2003b). Music therapy applications have been shown to be effective in medical settings for a wide range of diagnoses and ages (Standley, 2000).

One aspect of healthy functioning is wellness. Wellness has been described in part as a positive attitude towards, and active engagement in, one’s personal health environment. Wellness involves the creation of homeostasis for the individual by finding a balance between both internal and external environments. The uses of music therapy to positively affect physiological functioning as included in a wellness model have been discussed and reviewed by a number of
authors (Hanser, 1985; Lane et al., 1995; Standley, 1986; Taylor, 1987). One focus of wellness is often stress management and relaxation. Music-based interventions related to wellness, stress reduction, and relaxation can include a variety of experiences ranging from active and expressive activities such as singing and playing instruments to receptive and passive activities such as music listening (Davis and Thaut, 1989; Hanser, 1985) The effect of music on anxiety and on the physiological indicators associated with stressful experiences have been examined by a number of studies (Lai, 2004; Lai et al., 2006).

2.4.1 Need of Music Specification

In order to understand how music can be applied therapeutically one must first understand the basic principles of sound and hearing. Sound is vibratory energy (waves) transmitted through a medium (air, water, etc.). Sound waves move via compressions and rarefactions; the number of compressions and rarefactions per second is known as Hertz (Hz). Human beings can hear sounds that range from 20 to 20,000 Hz, with the greatest sensitivity found between 1000 and 4000 Hz (Lasky and Williams, 2005). Sound waves are transmitted through the hearing apparatus and converted from mechanical energy into electrochemical energy. Sound waves are transmitted through the fluid filled cochlea in the inner ear, with lower frequencies peaking near the apex and higher frequencies peaking near the base. Outer hair cells in the cochlea are bent through a shearing motion caused by displacement this in turn bends the inner hair cells, opening potassium channels. The inner hair cells become polarized, sending transmissions along the auditory pathway to and from the brain via the VIII th cranial nerve, which is completely myelinated by the 5th month post-conception (Lasky and Williams, 2005).

In order to study the biological effects of music, a study exposed young adult mice to slow rhythm music (6 h per day; mild sound pressure levels, between 50 and 60 dB) for 21
consecutive days and evaluated the levels of BDNF and NGF in the hypothalamus. This is the first evidence that music may change neurotrophin levels in the hypothalamus. However, alterations in neurotrophin content in other brain regions after music exposure have already been reported. In prenatal life, exposure to music causes an increase in hippocampal neurogenesis in rats.

The tempo of the music seems to be the most important factor in the studies analysed. Use of slow and flowing music with 60 to 80 beats per minute appears to have positive outcomes on relaxation and pain relief. Recommended type of music was non-lyrical consisting of low tones with strings, and minimal brass percussion. A volume level at 60 dB was also recommended. Despite several papers advocating patients' own choice of music, no significant difference was found between patients who selected the type of music and those who did not choose (Nilsson, 2008).

The purposes of this study were (a) to ascertain how 3 different volume levels of music affect the relaxation response both psychologically (preference scores and self-report) and physiologically (heart rate), (b) to determine the amplitude preference for relaxation among young adults, and (c) to compare differences in preference response between music and non-music majors and between the genders. Subjects listened to 27 minutes of music while relaxing. The amplitude of the music was changed every 3 minutes in a randomized order so that each subject received loud (80-90 dB) medium (70-80 dB) or soft (60-70 dB) music 3 times each during the experimental period for a total of 9 amplitude changes. A sample of subjects wore a small heart rate monitor on their wrist and chest during the procedure. Simultaneously with the selected listening, they were encouraged to turn a dial on a Continuous Response Digital Interface (CRDI) indicating their amplitude preference for relaxation. Self-report information
was gathered at the beginning and at the end of the experiment. Results of the CRDI analyses indicate that overall, subjects showed overwhelming preference for the soft music in comparison to medium or loud. Overall, there was an increase in relaxation reported over the duration of the experiment. Response differentiation to loudness levels indicates a long line of useful research not only on relaxation and stress reduction in health related fields, but also on the effects of background amplitude of music while studying, driving, and engaging in other cognitive and motor tasks (Yanagihashi et al., 1997).

The music interventions were held in a quiet classroom and lasted for 20 min during the course experiment. The temperature of the classrooms where the study was conducted ranged between 26 and 27 °C. All subjects in the music session were seated. The music was a selection of commercially recorded classical music played with earphones at 60-64 dB as measured at the CD player. This music dB level was chosen to be slightly louder than the background noise, which was found to average 55 dB during daytime quiet periods (Anand B. K, 1991).

The tempo of the music seems to be the most important factor in the studies analysed. Use of slow and flowing music with 60 to 80 beats per minute appears to have positive outcomes on relaxation and pain relief. A volume level at 60 dB was also recommended the use of music intervention is effective in reducing heart rate, blood pressure, respiratory rate and blood cortisol levels (Nilsson, 2008).

Listening to music for 20 minutes has been substantiated in the literature; however, frequency of this intervention has not been established through research. The taped music chosen for use in this study met the criteria for eliciting a relaxation response identified in the literature and included the following: (1) no dramatic changes, (2) consonance, (3) instrumental music, and (4) 60 to 70 beats per minute.7-13 Patients chose the type of music that would be most relaxing for them: easy listening, classical, and jazz. Based on previous studies in the literature, the music
was delivered on tape by headphone for 20 minutes twice per day, in the morning (between 8 AM and 10 AM) and in the evening (between 4 PM and 9 PM) on POD 1 to 3.10-14 For both groups, measures for pain intensity, anxiety, HR, and BP were obtained immediately before and after each 20-min (Boso et al., 2006).

Standley (1986), reported that slow, quiet, non-vocal music lowered the physiological responses associated with stress, whereas music with a faster tempo generally heightened them. Generally, soothing music contains no accented beats, no percussive characteristics, and no syncopation. The tempo of the soothing music was about 60 to 80 beats per minute (Chen et al., 2008).

Decades of research indicate that the most relaxing music has a tempo of approximately 60 beats per minute, is composed of predominantly low tones, and is largely stringed in composition, with minimal brass or percussion (Weinberg and Comer, 1994).

Sedative music was operationalized as music without lyrics and with sustained melodic quality with rate of 60 to 80 beats per minute and the general absence of strong rhythms or percussion, the volume and pitch was controlled so that the music was heard comfortably. High tempo contemporary music is often used to increase athletic performance (Kathi and Suzanna, 2005).

Music with slow, quite non vocal music lowered physiological responses associated with stress whereas Music with faster tempo generally heighten them, generally soothing music contains no asserted beats, no percussive characteristics no syncopations (Hui-Ling, 2004).

The HF component of HRV decreased in pleasant music but increased in WN. In previous studies on short-term and long-term behavioral and psychophysiological effects of WN with different intensities (55, 70, and 85 dB), we found that auditory stimulation with WN of mild intensity (55dB) evokes an orienting response mediated primarily by phasic
parasympathetic activation. This stimulation can be tolerated by participants for at least 2-3 minute without signs of excessive physiological arousal that is accompanied by subjective distress such as found with the sympathetic dominance (Sokhadze et al., 2000).

Music therapy was provided in group settings in majority of the studies. Three studies (Hanser, 1994; Pavlicevic, 1994; Talwar et al., 2006) used exclusively individual sessions; two studies (Thaut, 1993; Yang et al., 1997) combined group and individual sessions. Findings indicate that the effects of music therapy increase with the number of sessions provided. The number of sessions explained high proportions of the variance in effects (between 73% and 78%), indicating a clear and strong relationship. With the findings from this review, it is now possible to predict the expected effect size from the number of sessions, or to predict the number of sessions needed to achieve a given effect size. The results indicate that small effects are seen after 3 to 10 sessions; medium effects are achieved after 10 to 24 sessions and large effects after 16 to 51 sessions (Gold et al., 2009).

Dossey et al., (1995), the results furthermore indicated that a single music therapy session was effective in reducing anxiety and promoting relaxation. Although 20 minutes is thought to be an adequate period of time to induce the relaxation response, empirical evidence suggested that single session music therapy can be clinically effective despite its limited duration (Silverman and Beech, 1984; Tudiver et al., 1992; Zhu et al., 1996), Listening to music enhances cognition and learning (Rauscher et al., 1998, 1993).

Previous research suggests that at least about 20 sessions are needed for music therapy to have an effect (Jones and Swain, 1992). In cases where it is not possible to provide the maximum number of sessions, therapists should try to ensure that at least 18 sessions be given within the three-month period.
Properly selected music can elicit a relaxation response in a number of ways. Music may act as a distraction and divert attention from the stressful stimuli (G feller, 1992) or it may act directly on the autonomic nervous system (Brody, 1984). Furthermore, music may summon memories of past experiences and associated emotional responses. When a relaxation response occurs, the stress response is interrupted and anxiety levels are decreased (David, 2003).

Music therapy was shown to be more effective promoting relaxation and reducing anxiety by non-pharmacological means in relieving stressful situations (Chlan, 1998). Music should not be played continuously as it can lead to irritation rather than a state of wellbeing (O’Sullivan, 1991).

The degree to which the listener must compare the music selection to experience in these changes is not clear, with some studies reporting that the degree of liking for music is positively related to the degree of relaxation that listeners self-report (Allen and Blaskovich, 1994) and others indicating that the degree of preference and the level of relaxation obtained from music can be idiosyncratic (Davis and Thaut, 1989). In addition, the presence or absence of choice over music appears to not facilitate or inhibit the degree of relaxation that listeners self-report (Thaut and Davis, 1993).

The selection of specific music is chosen because of its shift from a stimulative music segment to a sedative music segment, which previous research suggests is more effective for relaxation than sedative music alone (Rider, 1985).

Results of evaluations of music activity and music preference for musical stimuli in preliminary research determined participation in the study. The music used in this study included the 4th movement of Tchaikovsky's Symphony No. 4 as an excitative piece and the 3rd movement of Mahler's Symphony No. 6 as a sedative one. The excitative music aroused feelings of vigor and tension more than did the sedative one, while sedative music eased tension. Favorite
music, regardless of music type, lowered subjective tension. Physiological responses (heart rate, respiration, and blood pressure) were greater during excitative music than during sedative music. Music preference did not, however, affect physiological responses. These results indicate that the dominant factor affecting emotional response was music type but not preference (Iwanaga and Youko, 1999).

Nursing interventions aimed at reducing patient anxiety and including music therapy, sensory information, progressive muscle relaxation, guided imagery, biofeedback, humor and storytelling (White, 1999). Music therapy is the systematic use of music to produce relaxation and reduce psychophysiologic stress (Chlan, 1998). The previous studies support that effect of music intervention also gives result music therapy is given by non-music therapist.

Soothing music has been found to be the most appropriate type to reduce anxiety. However, personal preference of the patient is important when selecting type of music to reduce anxiety. Furthermore, cultural norms may determine which music is enjoyable and pleasant. Moreover, tonal systems in Western (European) music differ from that found in Asian or Chinese culture (Davis-Rollans, 1987). Thus, music perceived as soothing in one culture may not be perceived as soothing in another due to cultural variations. Emphasis should also be placed on adapting the style of music (classical, modern, jazz, easy listening, rock, electronic, world music, etc.) to the patient's receptiveness (Gardner, 2000).

Music preference plays a large role because people generally like what they know and dislike the unfamiliar (Lai and Good, 2002). As early as 1929, researchers had concluded that a subject's interest in and appreciation of music was more important than the type of music listened to in terms of physiological responses elicited (Standley, 1986). This conclusion was confirmed by a recent study (Lai, 2004). Knowing the music selections prior to the playing of them ensured that the students internalized the main rhythmic and melodic concepts before mastering the technical aspects of relaxation.
Hui-Ling Lai et al., (2004), The purpose of his study was to identify individual musical preferences, investigate the relationship between an individual's musical preferences and demographic variables, and examine the effects of the selected music on relaxation. Fifty healthy. Musical preference interviews and relaxed responses to selected music were administered; they listened to the selected music for 20 minutes. The results indicated that Chinese orchestral music was the preferred choice, followed by harp, piano, synthesizer, orchestral, and finally slow jazz. There were no differences among types of music on relaxation, and no significant differences between musical preference and any demographic variables. The heart rates and respiratory rates of the participants were significantly lower (t = 21.24, P < .001 and t = 20.09, P < .001, respectively). Finger temperature (t = -33.20, P < .001) raised significantly after listening to the selected music. The results of this study demonstrated that when individuals listened to their preferred type of soothing music, physiological measures indicated lower heart rate, lower respiratory rate, and higher finger temperature, indicating positive effects of sedating music on relaxation.

Caine, (1992) found evidence that playing recorded music for infants in the neonatal intensive care unit increased weight gain and shortened lengths of stay. Moreover, a follow-up study of the infants that participated in Caine's music listening study indicated that infants who participated in the music intervention were rated as calmer by their mothers at 6 months of age compared to infants without music intervention.

Further studies have also shown that longer exposure to music, as well as music training, results in longer-lasting physiologic effects, as well as anatomic differences in brain architecture between musicians and nonmusicians (Schneider et al., 2002).
The results concerning the affective component of symptom changes showed that the effect of music therapy was sustained. One week after the discontinuation of sessions (Guetin et al., 2009).

One type of especially created music tape uses binaural beats to facilitate mood effects. Binaural auditory beats are produced by the brain as it processes similar but distinct auditory tones presented separately through headphones into the right and left ears. When 2 different but similar pure tones are presented, one to each ear, the brain detects phase interference between the tones and binaural beats are heard. The sensorial integration of the 2 frequencies produces the perception of a fluctuating rhythm at a third frequency equal to the difference between the 2 original frequencies. For example, a stimulation of 100 Hz in one ear and 110 Hz in the other ear results in a binaural auditory beat of 10 Hz, below the frequency threshold of hearing. Many anecdotal reports suggest that binaural auditory beats elicit changes in states of consciousness and mood. One study found that participants had increased performance, vigilance, and mood when presented with electroencephalogram (EEG) beta-range binaural beats compared to EEG delta/theta-range binaural beats. Different binaural auditory beats have been associated with sleep, relaxation, and even enhanced attention and vigilance. The delta EEG pattern (0.5-4 Hz) is associated with sleep, the theta pattern (4-8 Hz) with sleep and meditation, the alpha pattern (8-12 Hz) with mild relaxation, and the beta pattern (12-30 Hz) with attention. In fact, studies on the clinical use of music to improve mood have indicated that music preference may be an important factor when evaluating the effectiveness of any type of sound stimulation for clinical use. Therefore, before beginning a large double-blind clinical efficacy study on the effectiveness of binaural auditory beats, the authors concluded that additional pilot work was needed to ascertain the patient preference of tapes.
It would also be advantageous to establish a correlation between a standardized psychological marker for anxiety and an objective physiological marker of the binaural beat stimulation, such as the EEG. Changes in salivary Cortisol before and after listening, along with changes in the STAI, may be a more appropriate outcome measure of anxiety in future studies. Such studies are warranted and would better address questions of the therapeutic efficacy of binaural beat stimulation (Rene-Pierre et al., 2001). Thus our study is concentrating more on physiological markers.

(Robert et al., 2004), Beginning in the early 1990s, scientifically based studies of the potential beneficial effects of music, in particular Wolfgang Amadeus Mozart's Sonata for Two Pianos in D Major, K448 (hereafter K448), began to be published in scientific, peer-reviewed journals. Rauscher et al., (1993) demonstrated transient enhancement of performance on Stanford-Binet spatial-temporal tasks during and after listening to the first movement (Allegro con spirito) of K448. Improvement in spatial reasoning skills on Stanford-Binet intelligence scale testing was demonstrated in the Mozart-exposed group. This positive effect lasted 10-15 minutes after a 10-minute exposure. During the effect, no interaction or main effects for pulse, as representative of arousal, were present. Thus, arousal as a basis for this effect was excluded. Further studies have subsequently tested the validity and reproducibility of this technique (Robert, 2004). Attempts to explain this phenomenon on the basis of either "arousal effect" or "enjoyment/relaxation effect" have been refuted by demonstration of the physiologic effect of Mozart's music on patients in coma/status epileptics and on rat maze learning (Rauscher et al., 1998).

2.4.2 Why music which is raga based and melodious?
Raag Darbari, music relates to the seventh chakra. All barriers of race, colour, beliefs and opinion fall away and are replaced by silence, joy and bliss beyond our wildest imagination, it is an experience of heaven on earth. It is a deep, meaningful and slow raag that features the sitar; the last part of the raga is a prayer to the Divine.

If we prescribe a particular music to a subject it may contain only ragas, which may not be good for him/her and there may even be many fast numbers having hard metal sounds, injurious to the nervous system. Just to hear one raga and leave it or repeating it (even if we ask the subject to do so) does not happen and there are practical difficulties in it.

Music therapy has risen challenges to the research in recent years, not only there is a tradition of quantitative research but qualitative research approaches have also been incorporated with in the discipline as if necessary for an clinical approach that involves both science and arts (Luciano, 2001).

2.4.3 Classical Music

Music therapy aims to improve functioning through the use of music-based methods which optimize an individual’s ability to engage with their environment and maintain relationships with people. Thus, by improving function across a range of health domains, music therapy helps to improve quality of life overall.

Listening to specific types of music is another concept considered to calm the emotions and reduce stress (Friedman, 2007; McCraty et al., 1995; Weinberg and Comer, 2004).

Indian classical music is one of the major art music systems of the world, with a written theoretical tradition going back nearly two thousand years. Apart from Western classical music, it is the only other world art music to have made it successfully onto the international concert stage. Its complex melodic and rhythmic systems, raga and tala, have inspired a number of
Western composers and jazz and popular artists, including Olivier Messiaen and the Beatles. There are in fact two Indian classical systems, the North Indian (Hindustani) and the South Indian (Karnatic), which has a shared theoretical basis, but different melodic and rhythmic modes, styles, and performance practices.

Most research on the effects of music therapy and acute myocardial infarction patients used classical music. The effectiveness of other types of music (eg, new age, jazz, easy listening), with components previously determined as most relaxing, requires empirical testing. Only if empirical evidence indicates that these types of music can elicit a relaxation response can clinicians prescribe other types of music with confidence (White 1999).

In conclusion, with the specific sound stimuli of the current study, a significant negative influence of noise (90 dB versus 65 dB) on the stressfulness and fearfulness of hens was reported, whereas the classical music (75 versus 65 dB) did not affect the level of stress of hens and had an increasing effect on their fearfulness. In this way, the belief that exposure to noise causes stress in farm animals seems to be true, but the claim that music can generally help to alleviate stress does not, with these specific sound stimuli (Campo et al., 2005).

With regard to direct physiologic effects, in animals, music changes neuronal activity with entrainment to musical rhythms in the lateral temporal lobe and in cortical areas devoted to movement. Steady rhythms entrain respiratory patterns. Listening to classical music increases heart rate variability, a measure of cardiac autonomic balance (in which increased levels reflect less stress and greater resilience), whereas listening to noise or rock music decreases heart rate variability (reflecting greater stress) (Chuang et al., 2010).

Burns et al., (1999) examined the effects of listening to classic, rock, and relaxation music on perceived and peripheral physiological indicators of relaxation. They found that
classical and self-selected relaxation music increased subjective perceptions of relaxation. Unfortunately, the physiological measures (HR, TEMP and muscle tone) in this study did not show significant effects, a finding that may be due to less than optimal physiological measurement (e.g., HR measured by plethysmograph). Thus, the author's conclusion that listening to certain types of relaxation music for a short period may not have effects on level of physiological arousal must be considered tentative.

Classical music also has been used as a tool for relaxation and stress reduction, resulting in self-reported, behavioral, and physiological changes that are related to reduced stress, (Hanser 1985). For example, listening to classical music was associated with reductions in autonomic activity and self-reported tension and improved performance of surgeons (Allen and Blaskovich, 1994). Similarly, listening to classical music in another study reduced self-reported fatigue, sadness, and tension (McCraty et al., 1998).

It is believed that classical Indian ragas can benefit a whole host of conditions ranging from insomnia, high and low blood pressure to schizophrenia and epilepsy. It is believed that there are other ragas that can help fight ageing and pain, too.

Music is considered the best tranquilliser in modern days of anxiety, tension and high blood pressure. Raga Darbari is considered very effective in easing tension. It is a late night raga composed by Tansen for Akbar to relieve his tension after hectic schedule of the daily court life. This raga belongs to Asavari That and is a complete raga containing all the seven notes. The seven notes are taken from various natural sounds of birds and animals. Pandit Jasraj's Ram Ko Sumiran Kar in Vilambit Ek Tal is one of the best available recordings of this majestic raga. Pandit Raghunath Seth's Raga Darabari (instrumental) in a Music Therapy cassette named Tanav is especially composed for easing tension.
Darbari Kanada, or simply Darbari, is a Hindustani raga in the Kanada family, which is thought to have originated in Carnatic music and brought into North Indian music by Miyan Tansen, the legendary 16th century composer in emperor Akbar's court. This tradition is reflected in the name itself; Darbar is the Persian derived word in Hindi meaning "court." As the most familiar raga in the Kanada family, it may sometimes also be called Shuddha Kanada or pure Kanada. It belongs to the Asavari thaat.

A project was done by P. Bharati, a physiologist and musician, who after a detailed literature survey selected 2 ragas: Raga Todi and Subhapanthuvarali for study. These were played to 25 people with hypertension and anxiety neurosis with beneficial results.

Steady rhythms entrain respiratory patterns, noise/rock music decrease heart rate variability (reflects greater stress), and classical music increase heart rate variability (reflects less stress). Salivary cortisol levels are lowered in those listening to music (Khalfa et al., 2003) (Indicate decreased stress).

Adults and teenagers listened to four types of music i.e. classical, grange rock, new age, designer. Classical music decrease tension but had little effects on their feeling, grange rock increase hostility, fatigue, sadness and tension, New age music and designer music increase relaxation, the latter has more effect (Kathi and Suzanna, 2005).

Physiological changes associated with listening to classical music and related to reduce stress included significant decrease in endorphin following one session of a combined progressive relaxation (McCraty R, et al., 1998).

Listening to classical music was associated with reduction of autonomic activity and self reported tension-improved performance of surgeons (Allen and Blascovich, 1994). Music can be categorized as a type of relaxation and could be used when patients are having more stressful
period of time during the postoperative hospitalization period. Many clinical findings indicate that music reduces Blood Pressure in various patients (Susan, 1995).

2.4.4 Why was human voice selected?

Naada in Indian music-naa from last syllable of praana (life energy) and Da derived from first syllable of dhahana (fire energy) makes naada and music therapy is based on the life energy or bioenergy of the singer and listener communicating each other and thus merging in advaitha with the cosmic energy. (Susan Greenfield, 1998) Hegel said the human voice is the most perfect instrument which unites in itself the qualities of both wind and string instruments because in human voice a column of air vibrates for note production and through the muscles, there comes to play the principle of tightly stretched strings. When a person is under stress, what he/she requires best is the presence of a loving person nearby and a comforting soothing voice to hear. These considerations prompted us to select human voice as the medium of my treatment instead of instruments only.

Factors that affect the effectiveness of music depend on individual difference i.e. music preference, stress level, level of interest. It may be important to tailor the intervention to patient’s desires and preference. Self-selected music enhanced speed and accuracy of surgeon (Kayako and Kazuhito, 2005). Stated that group music therapy is more effective than individual (Bittman et al., 2003).

Music may induce relaxation and distraction responses by the effect of rhythm and tempo on limbic and hypothalamic system. Soothing music was expected to have a therapeutic effect on relaxation. Listening to slow soft music will cause increase exercise endurance. Soothing music has been found to lower patient’s anxiety, stress, respiratory and heart rate.
Therefore, in this study, a classical music chosen with earphones at 60-65 dB as measured at the MP3 player flowing music with 60 to 80 beats per minute for 20 minutes once a day for 28 days. The temperature of the rooms where the study was conducted ranged between 26 and 27 °C. One week prior to the start of the main part of this study, a music appreciation lesson was held in order to allow the shooters to become familiar with the music selections that they would be listening to during the test.

2.4.5 Music and Cortisol

Judith et al., (2010) reported music therapy is a noninvasive intervention that can be used to reduce anxiety levels in the patient undergoing anesthesia. Stress response was measured during and after hernia repair surgery. Seventy-five patients were randomly assigned to three groups: (1) intra-operative music, (2) post-operative music, and (3) silence. The same surgeon performed all repairs. Anesthesia and analgesia followed a standard protocol. Stress response was measured during and after surgery using cortisol levels, blood glucose levels, immunoglobulin-A levels (IgA), pain levels, anxiety, blood pressure (BP), heart rate (HR), and oxygen saturation. There was a significant difference in cortisol levels between Group 2 and the control group. Group 2 also had less anxiety, less pain, and required significantly less morphine than the control group. Group 1 reported less pain than controls. Studies of neurophysiology and neurobiology of the musical experience review reported the ability of musical stimuli to activate specific pathways in several brain areas. It also addressed several neurochemical studies that indicated that biochemical mediators may be active in the musical experience.

Thirty patients who were scheduled to undergo cerebral angiography were randomly assigned to either music or a control group. Their cortisol and catecholamines, blood pressure, heart rate, and STAI were measured. The music group chose one of nine tapes the evening before
the angiogram (international pop, German pop, oldies, meditation, rock, techno, instrumental, classic, and traditional). State anxiety fell during the angiography in the music group but was stable in the control group. The difference, however, was not significant. Patients in the music group had a significant decrease in blood pressure, whereas the control group showed no change. Cortisol in the music group remained stable during the procedure, but it increased in the control group (P = .015). Patients who showed the most anxiety before surgery seemed to profit the most from music (Schneider et al., 2001). Sixty patients undergoing same-day surgery were randomly assigned to three groups. Before and during surgery one group listened to new age music, a second listened to a choice of music from four styles, and the third heard the normal or sounds. Plasma levels of cortisol and lymphocytes were measured before, during, and after surgery. Plasma levels of cortisol and levels of natural killer lymphocytes decreased during operation in both of the music-listening groups but increased in the control group. Interestingly, cortisol levels in the group given new age music were significantly higher than in those who had a choice of music (Leardi et al., 2007).

In another randomized controlled trial of 58 patients who had undergone coronary artery bypass grafting or aortic valve replacement surgery, on postoperative day one they were assigned to receive either 30 minutes of music followed by 30 minutes of uninterrupted bed rest (experimental) or 60 minutes of bed rest (control). All patients were tested before, during, and after the 60-minute interval, determining serum cortisol, heart rate, respiratory rate, mean arterial pressure, arterial oxygen tension, arterial oxygen saturation, and subjective pain and anxiety levels. After 30 minutes, there was a significant difference in cortisol levels between the music and the control group. However, after 60 minutes, there was no significant difference between the two groups. No significant differences were found in the other measures (Nilsson, 2009).
There was a significant difference between a group of healthy subjects who listened to music and the control group with no music. Salivary Cortisol levels of patients who listened to their favorite music before surgery went down while those of patients who did not listen increased. Though the conditions of participants were different, more than half of the participants in this study showed lowered Salivary Cortisol levels by music therapy, and thus the results were consistent with the findings of previous studies (Hisako Nakayama et al., 2009).

Among premature babies classical music increase weight gains (Standley, 2002). Music in peri-operative and waiting areas which increase the level of salivary immunoglobulin A and decrease serum cortisol level which is because of decrease in anxiety and stress (Bittman et al., 2003). It is proved that 20 minutes of music has more effect and music decreases heart rate and Blood Pressure (Luciano, 2001).

Assessment of psychological stress by salivary cortisol is also documented in several investigators and proposed that the best way to assess adrenal steroid immunomodulatory function is through the DHEA-to-cortisol ratio. An increase in this DHEA-to-cortisol ratio was associated with increased well-being in healthy adults in an emotional self-management program with DHEA enhancement correlating with positive affective states and diminished Cortisol correlating with stress (McCroty et al., 1998).

Clinical studies have demonstrated that the immunological effects of music are statistically correlated with a decrease in corticosteroid secretion. These include increases in salivary immunoglobin-A (IgA) and plasma interleukin-1 (IL-1) levels correlated with significant decreases in salivary and plasma and cortisol concentrations respectively. The experiment with mice, there was also a correlation between the restoration of the immune
parameters assayed and significant decreases in the stress induced increases in plasmatic ACTH levels of mice exposed to music.

2.4.6 Music and Heart Rate Variability

In recent years, many reports in music, psychology, and medicine have cited the anxiolytic effects of music. These effects have been examined for different music types and for self-selected versus experimenter-selected music. Perceived relaxation was elicited by sedative music (SM), which is characterized as melodious, delicate, harmonic, and romantic (Iwanaga and Moroki, 1999), and by self-selected music (Davis and Thaut, 1989; Thaut and Davis, 1993). On the other hand, stimulative and excitative music (EM), characterized as loud, dynamic, and rhythmic, elicited tension and excitement (Iwanaga and Moroki, 1999). However, the effects of music on physiological responses have not been consistent from study to study. Some studies showed that heart rate (HR) and blood pressure (BP) were decreased by sedative music (Knight and Rickard, 2001) and by self-selected music (Miluk-Kolasa et al., 1996; White, 1999). Other studies showed that music induced no changes in HR or BP (Davis and Thaut, 1989) and that any type of music increased physiological responses (Iwanaga and Moroki, 1999). (Davis and Thaut, 1989) have hypothesized that these inconsistent findings regarding changes in HR are caused by individual response specificity in the autonomic nervous system (Lacey and Lacey, 1980). Because HR has usually been used as an index of stress and anxiety, changes in HR should be observed if music indeed reduces stress (Hanser, 1985). Music may elicit differentiated responses that simple changes in HR do not reveal. The previous studies assessed the effects of music mainly by measuring average changes in HR from a baseline. Stress and anxiety, however, influence not only changes in response levels but also time series changes or variability in responses (Fiske and Rice, 1955).
Modulations in heart periods, or intervals between successive QRS complexes, originating from cyclical changes in control of the sinoatrial node by the autonomic nervous system are commonly referred to as HRV. Therefore, HRV analysis provides a means of assessing the rhythmical changes that occur in instantaneous heart rate (R-R intervals) in response to alterations in sympathovagal balance. Decreased HRV has been associated with increased risk after AMI. Increased stimulation of the sympathetic nervous system reduces HRV and increases heart rate and force of cardiac contraction; increases in parasympathetic activity decrease heart rate and increase HRV (White, 1999).

Music affects the body via entrainment. This is a process whereby two objects vibrating at similar frequencies tend to synchronise with one another. It causes a reduction in sympathetic nervous control and therefore a reduction in heart and respiration rates, metabolism, oxygen consumption, muscle tension, gastric and sweat gland activity (Lee et al., 2005). Reduced heart and respiration rates lead to less anxiety and can promote relaxation and studies also showed that the heart rate of the participants reduced during the music therapy session (Chlan, 1998; Hatem et al., 2006). Almerud and Petersson, (2003), demonstrated that respiration rate was reduced during the music therapy intervention and also showed a reduction in blood pressure. Music therapy is believed to cause the pituitary gland to release endorphins, the body's natural opiates, thereby relieving pain (Wong et al., 2001).

Iwanaga and Tsukamoto (1997) examined the HF and LF components of subjects as they listened to each of six musical pieces. They reported that sedative music produced a greater increment of the HF component than excitative music. Concerning heart rate variability since sedative music is thought to have a relaxing effect, it is assumed to activate the parasympathetic nervous system (PNS) and inactivate the sympathetic nervous system (SNS). That is, sedative
music might increase the HF component. Similar results were obtained by (Yanagihashi et al., 1997) by using synthesizer music and by (White, 1999) using self-selected music. These results indicate that PNS activity is related to music's relaxing effect. As such, the HF component as a measure of PNS is considered a good index of the sedative effects of music. However, it is difficult to extract SNS activity from HRV independently, because the LF component represents the combined activities of the SNS and PNS. (Hayano et al., 1990, 1991) proposed the LF/HR ratio as a measure of SNS. Since (Yanagihashi et al., 1997) found that noises such as mechanical sounds increased the LF/HR ratio, they concluded that the LF/HR ratio might serve as an index of SNS activity.

The HF component of HRV is strongly influenced by respiration. However, the respiration rate was not controlled in most studies dealing with HRV in subjects listening to music. To examine the HF component, it is important to control this rate either directly or indirectly (Grossman, 2001). Moreover, most studies examined the effect of listening to music only once. In daily life, many people listen to their favourite music repeatedly. As repeated listening to music affects people's preference for it as well as their physiological responses to it (Iwanaga et al., 1997; Knight and Rickard, 2001), the HF component of HRV might increase with repeated listening.

HRV, on the other hand, was sensitive to differences in experimental conditions. The LF component and the LF/HF ratio increased during EM and SM but decreased during NM. Because the LF component and the LF/HF ratio for both sedative and excitative music showed patterns contrary to those of the control, these two indices might reflect the existence of musical stimuli. Since the LF/HF ratio is considered to reflect SNS activity (Hayano et al., 1991), musical stimuli might also help activate SNS.
On the other hand, the HF component was higher during SM than during EM, but it was the same between SM and NM. This pattern was similar to those of the changes in perceived relaxation. Therefore, the most sensitive index of music's relaxing emotional effect may be the HF component of HRV, which is considered to reflect PNS activity. Excitative music decreased PNS activation. These results regarding HRV support the findings of previous studies (Iwanaga and Tsukamoto, 1997; White, 1999). Since the HF component of HRV was reduced during stress tasks (Dishman et al., 2000; Hughes and Stoney, 2000) and by mechanical sound (Yanagihashi et al., 1997), the HF component is decreased by stress and uncomfortable stimuli. Therefore, the HF component may be sensitive to stress elicitation and reduction.

The HF component during SM was the same as that during NM. The decrement of HF was observed during EM. These results show not that sedative music increases PNS activity, but that excitative music may decrease it. However, the difference in PNS activity between the sedative and excitative pieces was observed in the first session but not in the third of fourth. The HF component for excitative music gradually increased, even though the increase was not statistically significant. The same pattern was found in perceived relaxation for excitative music: a gradual increase with repeated exposure. In contrast, the HF component and perceived relaxation for sedative music remained nearly the same regardless of repeated exposure. The differences between sedative and excitative music narrowed through repetitive exposure. Although excitative music may facilitate musical tension and decrease PNS activation at first, repetitive exposure to excitative music may induce relaxation mentally and physically. Music, unlike the no-music control, may increase both SNS and PNS activity. The no-music control may increase only the PNS and decrease the SNS. Although the same relaxed moods were elicited by both SM and NM, the balance of the ANS differed between these two conditions.
In the HRV data taken during the final session of each condition, the HF and the LF components each reversed its general trend found in the first three sessions. These reversals might be a consequence of the experimental design. Because all subjects were tested in three experimental conditions, they knew that each experimental condition would end after the fourth session. The effects of this knowledge and the consequent expectations might be reflected in the responses during the fourth session.

Because the respiration rate strongly affects the HF component of HRV, to assess this component it is necessary to control respiration cycles (Grossman et al., 2001). However, as the respiration cycle is influenced by musical tempo, it is difficult to maintain the same respiration rate during music that is maintained without music. It is considered a dual task for a subject to control the respiration rate while listening to music. Although we used an indirect control method by excluding participants who respired unstably or slowly, the effect of respiration cycles on the HF component could not be excluded completely. To assess the HF component, it is necessary to develop a new method of controlling respiration or to use appropriate statistical procedures. Moreover, we used only heart rate to examine the effects of music. To assess the hemodynamic process in subjects listening to music, it is important to measure other autonomic responses, such as systolic and diastolic blood pressures and cutaneous blood resistance (Iwanaga et al., 2005).

HRV is known to provide a unique viewpoint of autonomic regulation of heart. The HF component of HRV is known to represent parasympathetic regulation of heart, and the LF component is jointly contributed by both sympathetic and parasympathetic nerves. The %LF and the LF/HF ratio are considered to reflect the sympathetic nervous system (Kuo et al., 1999). The HF component of HRV has been shown to be a sensitive index for the effects of music on
relaxation (Iwanaga et al., 1997; White 1999). (Chuang et al., 2010), in this study, the HF power was significantly higher and the LF/HF ratio and %LF of HRV were significantly lower at posttest than at pretest. These results suggest that music therapy facilitates parasympathetic activities related to the relaxation sensation.

White, (1999) Relaxing music can induce a relaxation response, thereby reversing the deleterious effects of the stress response. Forty-five patients, with acute myocardial infarction were assigned randomly to 20 minutes of (1) music in a quiet, restful environment (experimental group); (2) quiet, restful environment without music (attention); or (3) treatment as usual (control). Anxiety levels and physiological indicators were measured. Results showed immediately after the intervention, reductions in heart rate, respiratory rate, and myocardial oxygen demand was significantly greater in the experimental group than in the control group. The reductions in heart rate and respiratory rate remained significantly greater 1 hour later. Changes in heart rate, respiratory rate, and myocardial oxygen demand in the attention group did not differ significantly from changes in the other 2 groups. Increases in high-frequency heart rate variability were significantly greater in the experimental and attention groups than in the control group immediately after the intervention. State anxiety was reduced in the experimental group only; the reduction was significant immediately and 1 hour after the intervention.

The very low frequency band (0-0.04 Hz) is the least understood of the 3 regions and is thought to reflect thermoregulatory feedback mechanisms, renin-angiotensin activity, and circulating neurohormone levels. The low-frequency component (0.04-0.15 Hz) reflects both sympathetic and vagal input to the heart and the activity of chemoreceptors and baroreceptors. The origin of the high-frequency band (0.15-0.40 Hz) appears to be the parasympathetic nervous system exclusively (White, 1999).
2.4.7 Clinical Studies on Music

Davis and Thaut, (1989) described a number of ways in which music listening may enhance relaxation. One use is listening to music as a masking agent to cover over unwanted environmental stimuli, such as background sounds that might induce stress or prevent relaxation (Radocy and Boyle, 2003). Another use is to provide distraction from other foci of awareness such as existing stress or physical pain (Robb, 2003). Both of these effect areas (masking and distraction) may co-exist with physiological effects of music listening, and may be beneficial to the listener in enhancing their own relaxation process.

One of these factors in closing pain gates may be messages descending from the brain through the spinal cord through what are termed efferent (descending from the brain) pathways. These descending messages may include the effects of processes in the brain resulting from listening to relaxing music. As a result, a positive and relaxed state of mind enhanced by music listening may therefore result in fewer pain impulses reaching our conscious awareness.

Receptive forms frequently involve an adjunctive activity performed whilst listening to live or recorded music, such as relaxation, meditation, movement, drawing, reminiscing etc. Aims in this sort of music therapy might include reducing stress, soothing pain, or energising the body. In a psychodynamic approach, listening to songs might help access feelings which the client can then work through verbally. For older adults, it might facilitate structured reminiscence or life review (Bruscia, 1991).

Recent laboratory experiments confirmed that musical harmony is based on inborn mechanisms. Babies (beginning at 4-month) like consonant sounds and dislike dissonances. Evolution, it seems, used the mechanical properties of the ear for enhancing efficiency of the spoken communication channel. As a string made of inhomogeneous material sounds in
discordance with itself, so does the human voice chord, when in stress or fear; it sounds discordant; and this discordance was perceived as unpleasant millions of years ago (Laura and Gary, 2002).

The Agency for Healthcare Research and Quality (AHRQ) recommendations regarding pain management included cognitive-behavioral interventions such as relaxation, music, distraction, and imagery. These nonpharmacological interventions have been shown to reduce pain, anxiety, and the amount of drugs needed to control pain (USDHHS, 1992).

Several researchers have examined the effects of music or music with relaxation on patients who have experienced a cardiac event, such as a myocardial infarction or angina, and demonstrated significant reductions in heart rate (HR), systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, respiratory rate, myocardial oxygen demand, increased peripheral temperature, anxiety happier emotional state or mood (White, 1999).

Sue et al., (2006) investigated the effect of music therapy on physiological and psychological outcomes for patients undergoing cardiac surgery. Cardiac surgery is a common interventional procedure, accompanied by postoperative pain and anxiety. The use of music therapy has been shown to reduce pain, anxiety, and physiological parameters in patients having surgical procedures. Author compared the effects of music therapy versus a quiet, uninterrupted rest period on pain intensity, anxiety, physiological parameters, and opioid consumption after cardiac surgery. On a sample of 86 patients (69.8% males) were randomized to 1 of 2 groups; 50 patients received 20 minutes of music (intervention), whereas 36 patients had 20 minutes of rest in bed (control). Anxiety, pain, physiologic parameters, and opioid consumption were measured before and after the 20-minute period. Results showed that a significant reduction in anxiety (P < .001) and pain (P = .009) was demonstrated in the group that received music compared with the
control group, but no difference was observed in systolic blood pressure, diastolic blood pressure, or heart rate. There was no reduction in opioid usage in the 2 groups. Concluded
Patients recovering from cardiac surgery may benefit from music therapy.

Lee et al., (2004), suggested that providing self-selected music to day procedure patients in the preprocedure period assists in the reduction of physiological parameters and anxiety, yet, a relaxing environment can assist in the reduction of physiological parameters. The administration of self-selected music to day procedure patients in the preprocedure period can be effective in the reduction of physiological parameters and anxiety.

Robb, (2003) reported Contextual Support Model of Music Therapy provides a framework that functions as a springboard for music to promote positive coping skills in children. This child-centered approach encourages therapists to capitalize on the functions of music that support expression, identification, and decision making in children. Robb documented significant outcomes of hospitalized children based on the use of this model. The use of music to motivate children to engage and participate within a structured environment that supports their autonomy develops and facilitates positive coping skills for children at a very difficult time.

Yung et al., (2002), furthermore done a study, a group of 30 patients awaiting general anaesthesia for a transurethral resection of the prostate demonstrated lower state and trait scores after listening to 20 minutes of self-selected slow, rhythmic music (either Chinese or Western). The music intervention also significantly reduced blood pressures.

Another study, conducted with 100 non-orthopedic patients (varicotomy or laryngological) waiting in the preoperative area, used an individually designed 60-minute music program for half of the patients. The addition of music was associated with a decreased heart rate, blood pressure, and respiratory rate in the music-listening group as opposed to the group
that was left alone (P < .001). Individually composed music plans are of great benefit to the patient because music preferences vary among patients (Miluk-Kolasa et al., 1996).

Music listening had a consistently positive and statistically significant effect on reducing psychological parameters of pre-procedural state anxiety (Elizabeth et al., 2008).

A study of 93 patients, 48 who listened to self-selected music and 45 who did not listen, showed that changes in physiological signs such as blood pressure, heart rate, and respiratory rate were not significant after 30 minutes of music intervention. However, the experimental group of patients continued to report that anxiety and stress were lessened (Wang et al., 2002).

Investigators examined how music affects propofol and opioid requirements in 34 patients undergoing urologic procedures and 43 patients undergoing lithotripsy. Spinal anaesthesia allowed the patients to be awake, so other medication could be given through a patient-controlled system. Approximately half of each group of patients listened to music intraoperatively, whereas the remainder listened to regular or noises. Results showed that there was a significant decrease in opioid and propofol use in the group of patients who listened to music (Koch et al., 1998).

Perianaesthesia nurses are rarely present for normal labour and delivery, but they are often there during caesarean births when regional anaesthesia is used and patient anxiety is high. The effects of listening to music were studied in 64 married women between the ages of 20 and 40 whose singleton pregnancies were at term and who were to have spinal or epidural anaesthesia for a caesarean section. The women were randomly divided into an experimental and a control group. Anxiety was measured using the VAS. Physiological indices included oxygen saturation (SpO₂), temperature of the finger, respiratory rate, pulse rate, and blood pressure. The experimental group listened to their individual choices of music for at least 30 minutes from the
start of anaesthesia until the end of surgery. The control group received standard nursing care. Differences in physiological measures were non-significant, but differences in anxiety were significant (P < .05). The music-listening group reported greater satisfaction with the caesarean experience (P < .01) (Browning, 2000).

Music therapy may be effective in an area of outcome in which psychopharmacological treatments show limited success namely in the area of negative symptoms, including affective flattening or blunting, poor social relationships, and low motivation, among others (Andreasen, 1982; Buckley and Stahl, 2007; Buchanan et al., 2007).

Doak, (2002) reported that adolescents generally use music to relax, escape reality, and alleviate psychological pain, as it appears that the adults in our study used music as a form of positive reinforcement whereas the adolescents in Doak's study used music to remove aversive emotional states (negative reinforcement). This finding might indicate that the function of music within an individual's life changes as they enter adulthood.

Evans, (2002) reviewed previous randomized trials evaluating the effectiveness of recorded music compared with a control intervention on adult patients in a hospital setting. It was concluded "music as a single session intervention reduces anxiety and respiratory rate in patients admitted to hospital". Thus, the effect of music in patient environments is apparent (Pasty et al., 2001).

Researchers have found that the appropriate type of music used in the therapy session, apart from the ability to reduce stress, can cure the symptoms of insomnia, anxiety, depressions, etc. In addition, music can help to improve effectively in career performance and increase concentration (Paiboon et al., 2010).
Studies have also shown that music therapy stimulates cognitive functions, acts on anxiety, depressive phases and aggressiveness and thus significantly improves mood, communication and independence in brain-injured patients (Nayak et al., 2000).

Music therapy was used over a two-week period with patients with major depressive disorders. Depressive scores for the music-listening group were significantly reduced, as were their sub-scores of depression in comparison with controls (Hsu and Lai, 2004).

Perioperative patient anxiety is a pervasive problem that can have far-reaching effects. Among these effects are increased postoperative pain, increased risk for infection, and longer healing times. Many factors affect perioperative patient anxiety, including the need for surgery, perceived loss of control, fear of postoperative pain, and alteration of body image. According to the current research literature, perioperative education and music therapy can be used to successfully reduce surgical patients' anxiety (Laila, 2010).

Music used appropriately in childbirth is noninvasive, nonmedical, and has no known negative side effects. It is a personal and family centered technique that provides the mother with a sense of control and a method to enhance relaxation. The responses of the women in this study highlighted the power of music in affecting the mind body relationship, and reflected each mother's intensely individual human experience in using her own music in childbirth (Caryl, 2000).

(Pacchetti et al., 1998) reported a significant improvement in motor function, emotional function, and activities of daily living after music therapy. It is possible that music increases Brain Dopamine (DA) synthesis in the remaining DAergic nerve cells in the neostriatum and eases some symptoms of Parkinson’s disease.
Anxiety is defined as "a vague, unpleasant emotional state with qualities of apprehension, dread, distress and uneasiness" (Reber, 1985). A possible bidirectional relationship exists between anxiety and pain; thus if pain increases, so does anxiety (McGrath, 1990). Similarly, if anxiety decreases, pain will decrease. (Anderson and Masur, 1983) stated that cognitive and emotional factors can influence the perception of pain. Factors including fear, tension, anxiety, and perceived loss of control can increase the patient’s perceived pain through an increase of pressure on nerve endings through muscle tension. This supports the importance of stress reduction for better performance.

Music has a well-documented effect on alleviating anxiety, depression and pain in patients with a somatic illness (Siedliecki and Good, 2006).

Literature has suggested that music therapy can play a critical role in multi-faceted treatment processes and decrease impulsivity (Silverman, 2003). Because of its ability to motivate and engage SUD clients (Ghetti, 2004), counteract isolation (Soshensky, 2001), elicit surfacing of emotions and positive mood changes (Jones, 2005), decrease stress and anxiety (Cevasco et al., 2005)

Substance use and music therapy share one similarity: they both alter or produce an emotion or mood. In fact, a recent survey that linked mental illness diagnosis, drug preferences, and music preferences found that adolescents overwhelmingly used music to relax (Doak, 2002). Several participants reported using music and drugs to increase their energy and to escape reality. Doak (2002) concluded that adolescents were using drugs and music for similar purposes to alleviate psychological pain. Interestingly, Doak raises the concern as to whether music is being used to manage their psychological pain, i.e. be part of "a healthy process of self-regulation," or whether music forms part of the "unhealthy, distress-addiction cycle".
In facilitating emotion and mood responses, songs have been shown to be more effective than instrumental music (Stratton and Zalanowski, 1994). (Wheeler, 1985) also reported the importance of participant familiarity with the music and added that the pre-existing moods of the participants predetermined their mood responses. People initially displaying a depressed mood became less depressed after hearing music they liked, but remained depressed when they listened to music they did not like. In contrast, people who were initially happy became sad when they listened to music they did not like but remained happy when listening to music that they did like.

Experiential avoidance has been linked to a number of clinical disorders including Substance Used Disorder (SUD), particularly the avoidance of experiencing negative emotions (e.g. sadness, boredom, anxiety, and distress) (Zywiak et al., 1996). In these situations, people tend to use drugs in an attempt to either reduce the intensity of their negative feelings, or to escape or avoid them (Otto et al., 2004).

Given this new emphasis on concepts such as interoceptive cues, experiential avoidance, and emotion regulation, it is not surprising that music therapy, which essentially deals with enhancing insight into clients’ thoughts, emotions, and behaviors, as well as promoting emotional expression through the medium of music, is emerging as an effective therapy in SUD treatment programs. Music therapy shows promise as a component of treatment designed to evoke emotional experiencing in a safe (substance-free) context.

The majority of studies reviewed for this report demonstrated that music had a positive impact on both psychological and physical patient outcomes. No differences were noted in the results obtained in different clinical settings or in different countries. In most studies, the treatment groups that listened to music responded with lower blood pressures, lower respiratory rates, and lower heart rates. The results from the state and trait portions of the STAI were lower
with the music intervention, indicating that the anxiety patients perceived was less after listening to music. There were some studies that did not show significant differences between the treatment groups and control groups. In concert, a systematic review of 42 randomized controlled trials using music interventions in peri-operative settings led its author to recommend that music therapy be used in light of its potential to reduce patient distress (Chang et al., 2005).

Several systematic reviews and meta-analyses have been conducted to examine the effects of music therapy in the field of mental health (Gold et al., 2005). However, all interventions have shown positive results upon various dependent variables (Thaut, 1993). It seems that music therapy intervention preferences may be individualized and difficult to quantitatively discriminate, especially in the group treatment process. Perhaps using scripted, manualized, and randomized controlled clinical trials with larger sample sizes would further distinguish music therapy treatments with adults.

2.4.8 Physiology of Music

In the human brain, one of the most powerful sources of auditory stimulation is provided by music (Sacks, 2006). Listening to music is a complex process for the brain, since it triggers a sequel of cognitive and emotional components with distinct neural substrates (Peretz and Zatorre, 2005).

Recent brain imaging studies have shown that neural activity associated with music listening extends well beyond the auditory cortex involving a wide-spread bilateral network of frontal, temporal, parietal and subcortical areas related to attention, semantic and music-syntactic processing, memory and motor functions (Janata et al., 2002), as well as limbic and paralimbic regions related to emotional processing (Blood and Zatorre, 2001; Brown et al., 2001).
Studies of neurophysiology and neurobiology of the musical experience were reviewed in 2006. The review reported the ability of musical stimuli to activate specific pathways in several brain areas. It also addressed several neurochemical studies indicated that biochemical mediators may be active in the musical experience. By means of iconography of neural functions, researchers overseas have demonstrated that music and human brain are closely related, and various important musical elements have different impact on individual brain areas. Since there are endogenous rhythms in human body, musical rhythms can induce resonance (resonation, sympathetic response).

Basic acoustics show that music is different from all other sounds. The even complex vibrations of musical instruments and the singing voice produce acoustic characteristics perceived as pleasant, preferred auditory stimuli. Intentional sounds, such as music, are chosen for their potential for soothing, learning, and neurologic development. Unlike music, noise is an uneven sound vibration, which results in irregular frequencies with inconsistencies of tension, stress, and configuration. These inconsistent acoustic characteristics of noise produce fatigue and stress in the listener. Ambient noise is the totality of the noises in one's environment, which is present but not chosen. Listening to music promotes neurologic organization. Aural perception requires the translation of sound vibrations and is learned or developed over time. Music is an auditory stimulus with many cognitive elements that are neurologically processed simultaneously or in sequence, including melody, rhythm, harmony, timbre, form, style, and expressive characteristics. These cognitive elements are organized according to established rules of music within each culture. Repeated listening processes identify the organization and even allow humans to develop aural expectancies. It is theorized that this neurologic processing during music listening is a very pleasurable activity, because all cultures have developed highly
sophisticated musical systems. Acoustically, music is unlike any other sound; it is more pleasant, soothing, and interesting than noise and uses highly preferred frequencies and harmonics selected through centuries of refinement and development of a specific music type.

It seems that music can exert physiological effects through the autonomic nervous system, but the factors directly involved are still unknown. It has been shown that musical stimuli in humans activate specific pathways in several brain areas associated with emotional behaviours, such as insular and cingulate cortex, hypothalamus, hippocampus, amygdala, and prefrontal cortex (Bosso et al., 2006). Functional analyses have also shown that music listening modulates the activity of mesolimbic structures involved in reward processing including the nucleus accumbens (NAc), the ventral tegmental area (VTA), as well as the hypothalamus and insula, which regulate autonomic and physiological responses to rewarding and emotional stimuli.

Hypothalamus is a brain region which regulates body homeostasis and influences the neuroendocrine and immune systems. Activation of hypothalamic-pituitary-adrenal (HPA) axis is followed by the release of messengers, such as hormones, neuropeptides, neurotransmitters and cytokines, which in turn regulate neuroendocrine and immune response. These observations raise the possibility that some of the physiological effects of music are mediated by activation of hypothalamus and HPA axis. Hypothalamus seems to be also involved in pathophysiology of anxiety and depression where deregulation of the HPA axis has been observed. Altogether these findings suggest that music may affect hypothalamic functions.

The activity of hypothalamus might be influenced by the presence of the neurotrophins brain-derived neurotrophic factor (BDNF) and nerve growth factor (NGF), which belong to a class of proteins produced in the peripheral and central nervous systems and are involved in the
growth, survival and function of neurons. Interestingly, it has been demonstrated that BDNF is able to regulate glucose and energy metabolism by acting directly on the hypothalamus (Stefan et al., 2010).

In most humans, music can strongly affect emotion and mood, and such effects are among the main reasons to produce, and listen to, music. Neuroscience studies on music and emotion, show that activity in each and every so-called limbic and paralimbic brain structures can be modulated by listening to music, in both musically trained and untrained individuals.

Although not well defined, "limbic" and "paralimbic" structures are considered as core structures of emotional processing, because their lesion or dysfunction is associated with emotional impairment. How limbic (e.g. amygdala and hippocampus) and paralimbic structures (e.g. orbito-frontal cortex, parahippocampal gyrus and temporal poles) interact, and which functional networks they form is still not well understood.

A central structure within the limbic/paralimbic neural circuitry is the amygdala, which has been implicated in the initiation, generation, detection, maintenance and termination of emotions that are assumed to be important for the survival of the individual. Several functional neuroimaging and lesion studies have shown involvement of the amygdala in emotional responses to music. The first neuroimaging study showing activity changes in the amygdala was a positron emission tomography (PET) experiment (Blood and Zatorre et al., 2001), in which changes in regional cerebral blood flow (rCBF) were measured during "chills" (i.e. intense emotional experiences involving sensations such as goose bumps or shivers down the spine). Each participant listened to a piece of their own favorite music to which they usually had a chill experience. Increasing chill intensity correlated with rCBF decrease in the amygdala as well as the anterior hippocampal formation (Stefan et al., 2010) (Figure.2.3).
During the presentation of pleasant music, increases in blood-oxygen level dependent (BOLD) signals were observed in the ventral striatum (presumably the nucleus accumbens, NAc) and the anterior insula (among other structures). Dissonant music, by contrast, elicited increases in BOLD signals in the amygdala, the hippocampus, the parahippocampal gyrus and the temporal poles (and decreases of BOLD signals were observed in these structures in response to the pleasant music) (Stefan et al., 2010) (Figure 2.4).

Music was proposed to have a psycho physiologic effect; Music therapy may induce relaxation and distraction responses by the effect of rhythm and tempo on the limbic and hypothalamic systems. These systems are known to reduce activity in the neuroendocrine and sympathetic nervous systems (Guyton, 1996). Reduced neuroendocrine activity reduces corticotropin (ACTH) and the stress response. Reduction of sympathetic activity reduces blood pressure, heart rate, and respiratory rate and induces relaxation (Guyton, 1996). Soothing music has been found to lower patients' anxiety, stress, respiratory rate, and heart rate also indications of sympathetic nervous system effects (Standley, 1986). In addition, lower anxiety is expected to promote psychological well being by decreasing plasma norepinephrine and cortisol (Mockel et al., 1994) and enhancing relaxation and calmness (Updike P A., 1990). Therefore, soothing music was expected to have a therapeutic effect on relaxation. Other researchers have supported the relationship between soothing music and relaxation. Findings include decreased levels of anxiety, decreased blood pressure and heart rate and decreased cortisol hormone levels (Mockel et al., 1994).

2.4.8.1 The role of the limbic system

Our emotional and physiological responses to music may in part be mediated by the structures of the limbic system working together with cortical networks of cognition and conscious thought (Jourdain, 1997). The limbic system is a group of interconnected neural
structures that surrounds midline surfaces of our cerebral hemispheres, and lies a top the brainstem in what has been described as a border-like manner (Schneck and Berger, 2006). The limbic system is located in the temporal lobes of the brain, close to the auditory cortex where music and sound are processed. It is thought to use motivation and emotion to bring maximum benefit to the listener by stimulating impulses and substances that produce sensations of reward or punishment (Altenmuller, 2004). Often termed “the emotional brain,” the limbic system can in part be activated by environmental stimuli such as sound and music vibration (Altenmuller, 2004). The limbic system includes a number of structures such as the thalamus, amygdala, hypothalamus, and others. Of special importance is the amygdala, which is in part responsible for behavioral reactions to objects or stimuli perceived to the individual to be of special biological significance. The amygdala receives information from temporal regions of the cortex, which gathers information from visual, auditory, and somatosensory association areas of the brain. It has been described as being well informed about what is occurring in the surrounding environment, which again is important when that environment includes music (Altenmuller, 2004). The limbic system also includes the hippocampus, which plays a major role in memory. This can be important and useful when the music being listened to is associated by the brain with previous feelings of being relaxed (Schneck and Berger, 2006). In addition to the actual music being listened to, cortical and cognitive responses to music can include conscious thoughts and elicited imagery, which in turn can positively affect the limbic system (Rider, 1985). With music listening, imagery can be produced and provided by the listener or can be the result of imagery suggestions such as those found in music and imagery recordings designed specifically to facilitate relaxation (Krout, 2007). Some music relaxation recordings also include instructions for deep breathing and relaxation techniques such as those involved with progressive muscle
relaxation. The listener’s responses to these narrated relaxation instructions may also be considered cognitive responses which may affect the limbic system (Krout, 2007).
Figure 2.3: Illustration of some structures belonging to the limbic/paralimbic system. The diamonds represent music-evoked activity changes in these structures (see figure legend for references). Note the repeatedly reported activations of amygdala, nucleus accumbens and hippocampus, reflecting that music is capable of modulating activity in core structures of emotion. Top left: view of the right hemisphere; top right: medial view; bottom left: anterior view; bottom right: bottom view. (Stefan, 2010)
Figure 2.4: Schematic representation of anatomical connections of some limbic and paralimbic structures involved in the emotional processing of music (Fig2.3 and main text). ACC: anterior cingulate cortex; ant Ins: anterior insula; Am (BL): basolateral amygdala; Am (CM) corticomedial amygdala (including the central nucleus), Hipp: hippocampal.
Stress can have a negative effect on wellness by preventing a person from being able to relax (Robb et al., 2006). For example, during a stressful emotional response to internal stimuli such as pain, tension, or worry, the sympathetic (arousing) branch of the autonomic nervous system (ANS) increases activity. At the same time, the parasympathetic (inhibiting) branch of the ANS decreases activity. As a result, heart rate increases and blood vessels dilate or constrict to move blood toward skeletal muscles and away from the digestive system. Hormonal secretions of epinephrine (adrenaline) and norepinephrine can further increase blood flow to the muscles and, along with cortisol, cause glycogen stored in the muscles to be converted to glucose.

Cortisol serves to conserve blood glucose by helping to break down protein and converting it to glucose, thus increasing blood flow. Cortisol is secreted by the adrenal cortex, which is stimulated by the release of ACTH by the pituitary gland. What is termed the adrenal cascade can be initiated by mental activity such as anxiety, stress, depression, and feelings of hopelessness. This stress can cause the hypothalamus to produce corticotrophin releasing factor (CRF), which in turn stimulates the pituitary to produce ACTH. Again, listening to calming music may inhibit this adrenal cascade and release of hormones (Kulkarni et al., 1998).

The thalamus, mentioned earlier as an important part of the limbic system, also affects the ANS. Its responses to musical rhythms are especially important in facilitating relaxation, and they may be able to what is termed “entrain” rhythmic physiological movements within the body (Rider, 1985). Entrainment has been described as the natural predisposition for the human body and its physiologic processes to respond to and synchronize with both its internal and external environments, including sound and rhythm (Schneck and Berger, 2006). Entrainment via the nervous system may allow information from both the auditory (peripheral) and cortical (central)
systems to interact with autonomic nerve pathways and facilitate a relaxation response, in part via the previously described parasympathetic nervous system (Schneck and Berger, 2006). Engagement of the parasympathetic nervous system can facilitate relaxation by positively affecting heart rate, respiration, oxygen consumption, and blood pressure. It has been demonstrated that slow or meditative music may induce these relaxing effects via interactions with the autonomic nervous system (Kemper and Danhauer, 2005).

Hughes, (2000) concluded that a significant basis for the music effect was that "the super organization of the cerebral cortex resonates with the great organization found in Mozart music". Further research suggested that the basis for this music effect, not due to relaxation or enjoyment of the music, is explained by the trion model of the cortex. The trion model suggests three levels of activation (thus, "trion") of the columns of neurons involved in processing music, with this activation leading to priming, or enhanced functioning, of the neurons involved in spatial-temporal tasks. These columns exhibit spatial-temporal firing patterns, and the trion model, as discovered by Shaw, provides an explanation, or mathematical realization, of the functioning of these mini-columns. Ongoing research suggests this as the basis of the effect of Mozart's music on the brain and brain function. Thus, studies continue to suggest, and expand on, the concept of the neuroanatomic and neurophysiologic basis of the Mozart effect. EEG effects from exposure to music and music training have demonstrated specific areas of activation; other studies have looked at EEG activity related to music in general, as well as Mozart specifically (Shaw et al., 1999).

Research has shown that it is the right side of the brain which responds to the creative arts, including music. Every sound that goes into the brain will be carried through a series of electrochemical impulses through different pathways of the brain. Each sound not only registers
in the primary and secondary auditory sections, but is also stored up as a part of memory. Music requires constant collaboration between the two hemispheres and thus encourages more harmonious cerebral activity (Besson et al., 2001). Music listening may influence cognitive functioning via alternate pathways by helping to better organize cortical brain transmissions (Rauscher et al., 1993).

By its very nature, music has strong connections to both attention and memory systems. Brain imaging studies have shown that listening to real polyphonic music calls for rule based analysis and combination of sound patterns from multiple auditory streams, which naturally recruits bilateral temporal, frontal and parietal neural circuits underlying multiple forms of attention, working memory, semantic and syntactic processing, and imagery (Janata et al., 2002; Peretz and Zatorre, 2005).

Harvey in 1987 described the interrelationship of music, mind, and medicine in what would become known as biomedical music therapy, stating:

1) The center of control for the human organism is the brain;

2) Music is processed by the brain and through the brain, after which it can then affect us in many ways;

3) Music has a positive effect upon both neural functions and hormonal activity and, as such, can facilitate the healthy functioning of the body’s own immune and regenerative processes”.

2.4.9 Music in Sports
Music motivates exercisers to sustain effort and at the same time is used to dissociate from the exertive sensations stemming from their bodies (Karageorghis and Terry, 1997). It affects perceived exertion and exertion tolerance through several mechanisms. One is that music synchronizes the exercise pacing, tempo, and rhythm (Anshel and Marisi, 1978). Another mechanism is that music enhances arousal (Karageorghis et al., 1996), particularly when it has personal meaning for the individual (Karageorghis and Terry, 1997). Thus, music enables one to cope more efficiently with specific exercise modalities (e.g., those that evoke feelings of monotony and boredom) and with specific exercises that evoke feelings of pain (Karageorghis and Terry, 1997). Music was also found to affect the mood (Karageorghis and Terry, 1997), self-esteem, and confidence of exercisers (Taylor, 1987), and also to enhance the production of imagery. Finally, based on a qualitative data analysis, asserted that music enhances exertion tolerance through the diversion of attention from the exertive and uncomfortable physical sensations to the various features of the music (i.e., rhythm, melody, and lyrics). These mechanisms may also operate interactively during endurance running.

Several studies have shown that up-tempo music has enhancing effects on performance, while slow tempo music had detrimental or relaxing effects (Ferguson et al., 1994; Karageorghis et al., 1996). Others have shown both up-tempo and slow tempo music have improved performance when compared to a white noise condition (Becker et al., 1994). In contrast, (Copeland and Franks, 1991) failed to support the claim that loud and fast music enhances physiological and psychological responses in sub-maximal exercise (i.e., endurance task on a treadmill). In a literature review by (Karageorghis and Terry, 1997), the use of many music types was noted.

During the experiment, a tape player played music at constant volume (75% of maximum volume on the tape player’s scale). This volume was chosen in the pilot phase of the study to
overcome the treadmill noise and to establish a clear sound of the music while running. The effects of music are more prominent when the physical load is moderate or low (Karageorghis and Terry, 1997).

These findings suggested that music evokes a "distraction effect" during low intensity exercise, but might not influence the autonomic nervous system. Therefore, when jogging or walking at comparatively low exercise intensity, listening to a favourite piece of music might decrease the influence of stress caused by fatigue, thus increasing the "comfort" level of performing the exercise. Music is also highly complex, consisting of melody, rhythm and harmony. Due to such complexity, the physiological response to music and how music affects responses to exercise might not be simple. Thus, the mechanism of how music influences the body during movement is difficult to determine. Therefore, further studies of the effect of music during exercise should be studied in terms of electroencephalography, breathing, and stress hormones. Moreover, the reliability and validity of the experimental procedures should be determined (Yamashita et al., 2006).

The use of music to motivate shooters to engage and participate within a structured environment like a training camp that supports their autonomy develops and facilitates positive coping skills for a very difficult time like competition.

Research has shown that both individual and group reinforcement contingencies have improved practice efficiency (Hume et al., 1985). Researchers have suggested that music can be valuable in reinforcing of appropriate training activity when presented in sport settings (Schubert, 1986). Previous research has both suggested and demonstrated that providing contingent music has effectively improved performance.

(Kodzhaspirov et al., 1988), for example, studied the performance of 65 weightlifters and found that music stimulated their work capacity and raised the effectiveness of training.
Furthermore, they found that subjects expended greater effort while listening to preferred music and determined that music need not be played continuously to be effective (in some cases for which concentration is imperative, music can disrupt performance). When asked whether they liked to train to music, 96% of the study group responded favorably, believing that music made training easier, reduced the psychological stress of training, and improved skill mastery.

In another study Anshel and Marisi, (1978), reported 32 male and female physical education students performed a bicycle ergometer test under three conditions: a) synchronous movement to music, b) asynchronous movement to music, and c) no music. The major finding from this study was that music had a beneficial effect on the subjects' ability to endure the task, particularly when the music was synchronized to physical movement.

Hume et al., (1992) studied to determine whether music could be used as a reinforcer for increasing productive and decreasing nonproductive behavior of 6 competitive swimmers during the dry-land portion of a practice session. The musical reinforcement conditions resulted in large improvements in the percentage of productive behaviors over the baseline conditions of the contingent reinforcement group.

Recent cognitive and neuropsychological studies suggest that it may also enhance a variety of cognitive functions, such as attention, learning, communication and memory, in healthy subjects (Schellenberg et al., 2007).

Recent evidence suggests that listening to music that is enjoyable but unrelated to the cognitive task may even temporarily improve performance in tests of spatial-temporal abilities, attention and creativity (Schellenberg et al., 2007) in healthy subjects.

David, (2003) found music had an influence on mild driver aggression in high congestion but not low congestion. This is likely due to the fact that overall levels of driver aggression were
much lower in low congestion than in high congestion. Music has been found to reduce stress, anger, agitation, and arousal due, in part, to distraction (Wiesenthal et al., 2000). As the number of demands for attention increase, the amount of resources available to any single source is decreased. Music acts as a distracter in that it assumes a portion of cognitive or attentional resources that might otherwise be directed toward a negative or demanding stimulus (Baron, 1986). As attention to music increases, cognitive resources are diverted from negative stimuli, thus reducing negative affect and behavior.

Recent evidence in the literature indicates that music is beneficial to sleep quality. Tan, (2004) found that students who listened to pleasant and relaxing background music for 45 minutes every night before sleep for three weeks showed significant improvement in sleep measures, including better sleep efficiency, shorter sleep latency, and longer sleep duration.

Music has characteristic psychological and physiological effects on human and can also be used as a source of distraction in conscious patients. In an attempt to reduce stress, improving relaxation and relieving anxiety music has been proposed as a safe and inexpensive non-pharmacological and anti-anxiety intervention. Music is composed of auditory tunes and rhythms that do not direct the mind but restrict it and they relax the body as well (Good, 1996).

The development of the FSS enabled (Karageorghis et al., 1999) to examine the relationship between flow and the motivational qualities of music. In their study, the results revealed a significant association between ratings of the motivational qualities of music and perceptions of flow.

Evidence for the positive effect of music on performance can be gauged from a number of sources. For example, Ferguson et al., (1994) demonstrated that karateka (karate players) attained superior performances with the use of asynchronous (background) music during performance. Likewise, performance improvements were observed in treadmill running tasks
under conditions of asynchronous music (Copeland and Franks, 1991). Additionally, (Anshel and Marisi, 1978) provided evidence for improved work output under conditions in which music was synchronised with physical tasks (synchronous music). Studies that have investigated the stimulative or energising effects of music have also noted benefits in the performance of physical tasks (Karageorghis et al., 1996).

The influence of music in the promotion of flow state in an exercise context has been the subject of recent research interest (Karageorghis et al., 2002), with the prevailing view being that carefully selected music may promote flow. Careful selection of music entails consideration of participants' ages, socio-cultural background, and preferences as well as the task that the music is intended to accompany (Karageorghis et al., 1999). One mechanism through which music may impact on flow is by enhancing pre-performance mood. Indeed, in a recent review, (Terry et al., 1995) presented a strong case for the mood-enhancing effects of music in a sport context. Further, (Jackson, 1992) reported that pre-performance mood was a key antecedent of flow among elite figure skaters.

Karageorghis and Deeth, (2002) assessed the effects of asynchronous (background) motivational music and oudeterous (defined as neither motivational nor demotivational) music on perceptions of flow during an endurance shuttle running task. Significantly, this was the first study that controlled for the possible confound of variability in pre-performance mood (Jackson, 1992). Results from the repeated measures design indicated that the motivating music condition engendered significantly higher flow scores, as measured by the FSS, when compared to the no-music control condition.

The strong link between music and changes in motor behaviour and cognitive states may be explained in terms of (Norman and Shallice, 1986) cognitive model of behavioural control.
The model proposes that the cognitive system is comprised of a large, distributed set of specialized processing systems under the guidance of a two-tiered cognitive control system. In routine situations, behaviours may be controlled exclusively by the operation of low-level cognitive control structures or schemata, which are triggered by cues in the internal and external environment in accordance with a contention scheduling mechanism, which operates automatically without consuming attentional resources. This low-level of control is considered to be an automatic process, requiring neither attention/awareness nor volition for its operation.

When an individual is faced with novel demands, a second higher-level system can intervene to initiate behaviour via the active excitation or inhibition of schemata at the level of contention scheduling. This central cognitive structure, the supervisory attention system, is both a monitoring and a controlling system. This high-level control structure is not needed to select lower level schemata when processing demands are routine.

The components of motivational music (Karageorghis et al., 1999) more specifically, the extra musical associations that players had with their self-selected music been expected to rouse them towards optimal psychological state and superior performance. These results suggest that music may be an effective tool for improving performance in netball players.

The qualitative data suggest that music not only improves performance and increases feelings associated with flow but may also be used to help athletes cope with competition anxiety and to improve their self-confidence. These support previous researches that found music to be an effective tool for improving athletic performance (Copeland and Franks, 1991; Ferguson et al., 1994; Karageorghis et al., 1996; Lee, 1992).

In summary, findings suggest that a music intervention may enhance performance and trigger emotions and cognitions associated with flow. Further study is required to enable music-
related interventions to be accepted by the sports science community on the basis of strong empirical evidence. Specifically, now that the benefits of music have been repeatedly demonstrated in laboratory settings, more ecologically valid and group-based research methods would serve to bolster the knowledge base.

2.4.10 Music with Combination Therapies

Approaches aimed at reducing stress and anxiety, such as music therapy, biofeedback, and progressive muscle relaxation, are designed to elicit a psychophysiological relaxation response. Although many approaches have been reported, research on the effectiveness of these treatments is limited. One promising intervention is music therapy. Recognition of the therapeutic effects of music dates back to primitive humans, who believed that music, had the power to free the body of "evil spirits." Through the years, such prominent scholars as Plato and Pythagoras, Aristotle, and Nightingale have espoused the beneficial effects of music (White, 1999).

Some studies have also combined music with relaxation therapy or some other intervention (Fried, 1990; Lai and Good, 2005), making it difficult to draw conclusions on the efficacy of music to facilitate sleep onset, or to improve the duration or quality of sleep. One study which had both music and a relaxation therapy condition found that relaxation therapy had a greater effect on EEG spectral activity than music (Jacobs and Friedman, 2004). Some studies used relaxation therapy combined with music (Lai and Good, 2002), which makes it impossible to determine the effect of the music alone.

Another investigator analyzed the use of music through headphones in addition to relaxation techniques in patients undergoing gastroenterological procedures. Those who listened to music and practiced relaxation techniques had lower blood pressures and heart rates throughout the procedure (Salmore and Nelson, 2000).
A study in 2000 found that music enhanced other coping strategies used during labour such as imagery, breathing exercises, and distraction (Brown et al., 2001). However, in 2001, researchers asked 46 parturient to rate the effectiveness of 10 nonpharmacological methods of pain relief. Listed in order, the first four were breathing techniques, relaxation, acupressure, and massage. Although 96% of the mothers had been taught prenatally about listening to music, only six (13%) used it during labour, whereas a minimum of 23 (50%) used one or more of the other four techniques. Music enhances the effect of other relaxation therapies and also public interest more towards the other therapies. Thus this will support the effect of combination group result.

Breathing patterns comprise the third concept in the physiology of stress reduction. Breathing exercises and patterns are considered vital to promoting oxygen to the brain and facilitating learning.

Physiological changes associated with listening to classical music and related to reduced stress included significant decreases in p-endorphin following one session of a combined progressive relaxation, classical music, and guided imagery condition (McKinney et al., 1997a), as well as significant decreases in serum cortisol following 13 weeks of guided imagery and music therapy (McKinney et al., 1997b).

Several music therapy studies also indicate that music and progressive muscle relaxation has effective outcomes in controlling muscle tension, anxiety, sleep quality, and reducing stress (Robb, 2003).

It is important to note that when comparing music groups (music group and music combined with PMR group) versus non-music groups (PMR group & control group), the music groups exhibited a greater decrease in both anxiety and fatigue than non-music groups. Therefore, this suggests that music plays a vital role in decreasing feelings of fatigue by
providing a pleasurable stimulus, and thereby creating an arousal which increases a subject's engagement during PMR. It also suggests that music may enhance PMR as the movements of the relaxation technique can be entrained with the music, which may have ultimately decreased anxiety and fatigue. Therefore, these data support the PMR intervention being more effective when used in conjunction with music (Yoon, 2010).

Several investigators have studied the effects of relaxing music on the anxiety. The most consistent finding is a reduction in anxiety levels after relaxing music sessions. However, to date, the effects of relaxing music on sports performance demand and HRV have not been investigated in athletes. Moreover, the sustained effects of relaxing music have not been examined. Therefore, the purpose of this study was to examine the effects of selected relaxing music on HRV, anxiety, and sports performance.

2.5 Meditation as Therapy

Growing scientific evidence, clinical experience and community attitudes are encouraging a shift to more natural and holistic forms of therapy as alternatives or adjuncts to pharmacological approaches in a variety of conditions. Meditation has a wide range of applications, but it is especially useful in treating stress and related disorders. Meditation is easily adapted to the general medical setting. Recently, there has been a growth of clinical treatment and wellness programs based on mindfulness meditation and yoga, there is a growing interest in mind-body medicine and complementary and alternative therapies, as well as a desire to be proactive and take initiative in personal care.

The dissimilarities between studies on the physiological correlates of yoga may be due to the variability of yoga practices as well as methodological flaws (R L Woolfolk, 1975). Woolfolk also suggests that a lack in experience of those being studied may play a role in the contradictory findings. This notion that experience may play a role in the findings in research of yoga
meditation is supported by (Delmonte, 1984), who found in his review of two longitudinal designs that subjects showed significant changes in alpha EEG activity only after longer periods of practicing meditation (Glueck and Stroebel, 1975). Telles et al., (1997) found significant respiratory changes in girls at a community home only after 6 months of yoga practice. These observations support that experience may play a role in the physiological correlates of yoga meditation. Hence, more research with individuals who are highly experienced in meditation is needed.

Research data indicates that there are varying physiological correlates associated with meditation. Some studies, for example, show increased alpha or theta electroencephalograph (EEG) activity (Becker and Shapiro, 1981), whereas others show more beta or even some delta EEG present. Some studies show a decrease in heart rate (HR) and respiration rate (Wegner and Bagchi, 1961), whereas others show increases or no change in these measures (Corby et al., 1978). Similarly, there are paradoxical data on skin conductance level (SCL); some report an increase in skin conductance (Corby et al., 1978), whereas others report decreases (Jevning et al., 1992).

2.5.1 Types of Meditation

Meditation is the attainment of a deeply restful yet fully alert state practiced as a self-regulatory approach to stress reduction and emotion management (Mason et al., 1997).

Mikulas, (1990) proposed the usefulness of dividing meditation into four components (form, object, attitude and behaviors of mind). Of these components, form and object vary among meditation techniques. The expressions used for the behaviors of mind induced during meditation also vary, but there are two core components (or some weighted combination of both), i.e., manipulation of one's attentional focus (internalized attention) and maximization of
the breadth and clarity of self-awareness (mindfulness). In addition, attitude (the mental set in which one approaches meditation) is considered to be an important factor affecting behaviors of mind during meditation, although it is fairly well known that proficient meditation involves the cultivation of internalized attention and/or mindfulness (Mikulas, 1990).

2.5.1.1 Mindfulness Meditation

Mindfulness meditation is a meditation best represented in modern medicine, which emphasizes an open awareness to any contents of the mind that are emerging. After a period of practice, the patient is supposed to develop a sustainable attentive observational capability, without reacting to their own thoughts and emotions. Mindful state with equanimity helps to retrain or decondition the previous pattern of reaction which is usually poorly adapted to external reality. It is represented by mindfulness-based stress reduction programs (Kabat-Zinn et al., 1992). The techniques of mindfulness meditation which focus on awareness to develop a detached observation of the contents of consciousness may represent a powerful cognitive behavioural coping strategy for transforming the ways in which we respond to life events (Astin, 1997).

2.5.1.2 Concentrative Meditation

Concentrative meditation is another kind of meditation by two programs, Transcendental Meditation (TM) which was introduced to the West during 1960s and the 'Relaxation Response' developed subsequently by Benson which was developed subsequently (Benson et al., 1975). Concentrative meditation emphasises focusing the attention onto an object and sustaining attention until the mind achieves stillness. The objects of focusing could be varied from words, light, colours, geometric forms, ideas etc. Relaxation, clarity of mind, calmness is intended to result from continuous practice.
Thus, the operational definitions of meditation are the specific techniques of mind training which have two fundamental attentional strategies (Barrows et al., 2002).

1. Mindfulness meditation (opening-up, insight meditation) involves the continual maintenance of a specific perceptual-cognitive set toward objects as they spontaneously arise in awareness with a nonreactive attitude. The salient features are full awareness or mindfulness of any contents of consciousness with equanimity.

2. Concentrative meditation entails sustained attention directed toward a single object or point of focus. The aim is one-pointed attention to a single perception without distraction in order to produce the concentration or one-mindedness state.

Relaxation can be induced by meditation, for example, sitting quietly with eyes closed and with a relaxed accepting attitude. Shapiro, (1982) described three broad groupings of internalized attentional strategies in meditation: focusing on the whole field as in mindfulness meditation, focusing on a specific object within a field as in concentrative meditation, and shifting back and forth between the two as in integrated meditation (such as in transcendental meditation, Zen meditation).

Even though there was no significant difference between concentrative and mindfulness meditators when the stimulus was expected, mindfulness meditators showed superior performance when the stimulus was unexpected, suggesting the development of a more distributed attentional focus in mindfulness as compared with concentrative meditators. However, no significant difference was observed in other three studies, possibly because of excessively short practice (1 month) in two studies (Tang et al., 2007). Tang et al., (2007) also found only partial support for the notion that a 5 days mindfulness intervention could improve intelligence
levels as measured by means of Raven standard progressive matrices over simple relaxation training.

The concept of mindfulness has its roots in Buddhist philosophy and MMP is a key element of several Buddhist meditations including Vipassana (Gunaratana, 1993) and Zen meditations. In the last decades mindfulness training has been widely incorporated into several clinically oriented group based meditation programs such as Mindfulness Based Stress Reduction (MBSR) and Mindfulness Based Cognitive Therapy (MBCT). Where mindfulness skills are usually taught over a period of 8 weeks and practitioners are asked to meditate for about 45 minutes daily (Kabat-Zinn et al., 1992), current evidence suggests that mindfulness training could have significant benefit on health, including reduced alcohol and substance consumption (Bowen, et al., 2006), reduced blood pressure (Chiesa and Serretti, 2009), decreased anxiety, depressive symptoms and relapses (Coelho et al., 2007) as well as significant benefits for patients suffering from various types of chronic pain (Chiesa and Serretti, 2009), stress problems (Chiesa and Serretti, 2009), cancer (Ledesma and Kumano, 2008) and several further medical disorders (Chiesa and Serretti, 2010).

Even though many studies on MMPs have been criticized for the lack of scientific rigor, including the lack of high quality randomized controlled studies designed to differentiate between the specific (i.e. specifically related to repeated sitting meditation practice) and the non specific (i.e. related to benefits' expectations) effects of such practices (Chiesa and Serretti, 2010) and the frequent use of self report instruments as measures of clinical improvements following mindfulness training (Chambers, et al, 2008), overall available studies provide preliminary evidence for the clinical usefulness of such interventions. It is noteworthy, however, that the bulk of studies investigating the clinical benefits of MMPs. brief laboratory manipulations have been
considered as an important aspect of understanding how the meditation works physiologically in human beings.

Mikulas, (1990) defined concentration as the focus of awareness towards a single point or object. Examples of meditative techniques that predominantly utilize concentration are transcendental meditation and Mantra Yoga. Practitioners of both techniques either silently or quietly repeat a mantra (i.e., a sound, word, or phrase) or keep their attentional focus on the mantra. If other thoughts intrude into their consciousness during the meditation, they gently and firmly bring their attention back to the object of meditation (i.e., mantra). The ‘Su-soku’ task in this study is also characterized by concentrative meditation in which counting of respiration is the object of meditation. The counting procedure (i.e., counting breaths in synchronization with exhalation) may have enhanced concentration on respiration, resulting in essential physiological differences between the meditation condition and control condition. A previous study showed that proficient meditators demonstrated increased autonomic activation during meditation while inexperienced meditators demonstrated autonomic relaxation (Lazar et al., 2005) It was also reported that certain individuals, namely the psychologically ‘healthy’ and those with a capacity for relaxed absorbed attention, appeared to be more favorably disposed to meditation (Lou et al., 2005)

For Shavasana training the technique recommended by Coulter (Coulter, 2001) was used. The subject lay supine on a padded, but relatively firm, surface. The arms and thighs were comfortably abducted, the feet spread apart and hands were 12-18 in. (30-45 cm) away from the thighs, with forearms supinated. The subject was asked to relax and breathe abdominally. Shavasana was practiced for 10min. Finally the subject was ready to come out of relaxation by bringing the arms overhead and turning on left side before sitting up. (Madan Mohan et al.,
2002) emphasized that even 1 week of training of Shavasana can significantly modulate cold pressor response in normal subjects.

### 2.5.2 Meditation in Sports

It is developed through regular practice of mindfulness exercises, and with particular relevance to athletic performance, can be viewed as a form of self-regulated present moment attention. In addition to enhancing moment-to-moment attention, mindfulness-based techniques have also demonstrated efficacy in reducing the verbal-linguistic component of anxiety and worry. Further, as it has been suggested that the use of mindfulness techniques may lead to the development of greater self-awareness (Roemer and Orsillo, 2002), habitual ways of responding to external cues can be more easily identified, which may result in enhanced behavioural flexibility in response to athletic demands. Mindfulness-Based Cognitive Therapy (Segal et al., 2002) for use with an athletic population.

A study on 25 elite shooters found that the competition results in the outdoor season, just after meditation training period, compared with the results of the previous season, performance was better in the meditation group. They concluded that meditation might enhance competitive shooting performance. The effectiveness of different relaxation techniques has not been compared in sports settings (Solberg et. al., 2000). Reviews of the literature have found that more than 85% of studies showed significant improvement in performance after mental training (McCloy, 1978).

Stress reducing techniques such as meditation alter immune responses after strenuous physical stress (Solberg et. al., 1996).

The visual feedback processing time involves identifying, deciding, and initiating corrective action based on visual feedback. Visual processing time estimates have been
controversial. (Smith and Bowen, 1980) Estimation that visual processing time can be as low as 100 ms.

Yoga is an ancient Indian science which includes the practice of specific postures, cleansing practices, regulated breathing and meditation (Visweswaraiah and Telles, 2004). In the present single blind, randomized, prospective trial 291 persons working in a software company were evaluated for self-rated symptoms of visual discomfort. They were randomized as yoga (YG) The 60 minute yoga program included yoga postures (asanas, 15 minutes), regulated breathing (pranayamas, 10 minutes), exercises for the joints (sithilikarana vyayama, 10 minutes), visual cleansing exercises (trataka, 10 minutes), and guided relaxation (15 minutes) and wait list (WL) control groups. Both groups showed comparable discomfort at baseline. At the end of sixty days the YG group showed decreased scores, whereas the WL group showed an increase in visual discomfort. In shooting continuous training produces dry eyes this also affects the performance this study support the improvement in performance in shooting could be supportive to meditation (Shirley Telles et al., 2006).

Correlations between psychological and physiological measures are rare with only a few researchers taking a psychophysiological approach to the anxiety-performance issue. Interestingly, in this study we have used highly reliable physiological measures like Salivary Cortisol and heart rate variability to correlate the physiological approach to the anxiety in sports performance.

2.5.3 Role of Respiration on Meditation

Relaxation reduces the resting oxygen consumption rate, respiratory rate, heart rate, and the spontaneous galvanic responses. There was a noticeable decrease in respiration rate during meditation, the subject’s abdominal breathing pattern became more pronounced during meditation. There was an increase in abdominal over thoracic breathing during meditation; there
was also enhanced alpha EEG activity during meditation. The correlation between deep, slow, abdominal breathing and alpha EEG production suggests that this type of breathing pattern may contribute to the increase in alpha EEG as proposed by (Fried, 1990).

Sudarshan Kriya and related Practices (SK and P) is a form of yoga practice that emphasizes breathing exercises. In addition to asanas, three different forms of pranayamas are practiced in succession. Previous studies suggested that SK and P may be useful for relieving depression, improving the antioxidant defenses of the body, giving rise to beneficial EEG patterns, and possible improvements in blood chemistry. For example, Janakiramaiah et al. found that the degree of depression significantly decreased (68–73 %) in subjects with clinical depression after they practiced SK daily for three weeks and this decrease was as effective as conventional pharmacological treatment. Another study indicated concurrent high activity of both alpha and beta waves in the EEG in SK practitioners indicating focus and relaxation at the same time, suggesting improved brain function. A drop in blood lactate level, yet increase in the antioxidant enzymes superoxide dismutase, catalase, and glutathione, indicated favourable effects on antioxidant status. SKandP is traditionally understood to dissolve emotional distress and create the subjective experience of rest and well-being. SKandP is SK which is an advanced cyclical breathing exercise of slow, medium, and fast rates in succession. Slow breaths are about 20 respiratory cycles per minute, medium breaths are about 40–50 respiratory cycles per minute, and the fast breathing is about 60–80 cycles per minute. The participants in the SK and P program had decreased level of depression and anxiety as well as increased degree of experienced optimism. There was also a decrease of stress experience in the SK and P group compared with the control group. Furthermore, SK and P induced an altered state of consciousness (ASC) during the practice of the program, but not in the control group.
A slow respiratory rate (6/min) has generally favourable effects on cardiovascular and respiratory function and increases respiratory sinus arrhythmia, the arterial baroreflex, oxygenation of the blood, and exercise tolerance. Slow respiration may reduce the deleterious effects of myocardial ischaemia, and, in addition, it increases calmness and wellbeing. These effects result from, at least in part, synchronization of respiratory and cardiovascular central rhythms. A respiratory rate of around 6/min coincides with and thus augments the 10 second (6/min) Mayer waves, and so increases the power of vagal respiratory sinus arrhythmia. The favourable effects of slowed breathing may be mediated, at least partly, by a modulation of autonomic activity at both central and peripheral (baroreflex) levels.

Normal respiratory cycle is accompanied by changes in autonomic tone that modulates the heart rate. The activity of the vagal nerve endings increases during exhalation, and the activity of sympathetic fibers increases during inhalation, causing the “respiratory modulation” (RM) or “sinus arrhythmia”, i.e., during inhalation the heartbeat intervals shorten and during exhalation they stretch. The oscillation in vagal action is responsible for most of the RM, because it is faster than the sympathetic action (Berne, 1993).

During Kundalini Yoga and Chi meditation practices in healthy subjects, there have been reported extremely prominent heart rate oscillations correlated with slow breathing, with amplitude significantly larger than the RM measured in the same individuals before meditation (Peng et al., 1999).

In meditation contrast to a state of allostatic load, hypo arousal involves a slowing of metabolism, reduced energy expenditure, and a cognitively based broadening of awareness, which promotes relaxed awareness. Changes in breathing alter the balance of oxygen and carbon dioxide, in a range associated with mild hypercapnia (slight CO2 excess), heightened parasympa-
thetic tone, and a state of global somnolence. Formal meditation practice normally consists of sitting quietly, the first step in reducing activation.

Exercise physiologists use a benchmark figure of 3.5 milliliters of oxygen consumption (VO2) per kilogram of body weight as an average resting level. This corresponds to a caloric expenditure of approximately 1 kcal per minute. At this level, breathing rate averages between 12 and 15 breaths per minute, and heart rate between 60 and 70 beats per minute. A relatively high percentage of blood flow (15%) is shunted to the brain; digestive, growth, and restorative physiological processes are optimized; and there is comparatively little blood flow to skeletal muscle (Powers and Howley, 1997).

Clinical studies have proven that an increase of oxygen from correct breathing technique has a major effect on stress and anxiety. Deep breathing is most rapidly learning relaxation technique, very little training needed to obtain benefits (Umemura, 1998). Breathing is an automatic process governed by centers in the brainstem (Pons and Medulla). Regular practice of breathing exercise increases Parasympathetic tone, decreases sympathetic activity, improves cardiovascular and respiratory function, decreases the effect of stress and strain on the body and improves physical and mental health (Pal, 2004). (Plaster, 2006) Reckons that the most stable shot is the one taken within the 2 s period between exhaling and inhaling, known as the natural respiratory pause. Hence, good timing in relation to the breathing cycle can play an important role in the stability and accuracy of a shot.

2.5.4 Meditation on Anxiety or Stress

Meditation that cultivates mindfulness is particularly effective at reducing stress, anxiety, depression, and other negative emotions. Mindfulness is the quality of being fully engaged in the present moment, without analyzing or otherwise “over-thinking” the experience. Rather than worrying about the future or dwelling on the past, mindfulness meditation switches the focus to
what’s happening right now. Mindfulness meditation is not equal to zoning out. It takes effort to maintain your concentration and to bring it back to the present moment when your mind wanders or you start to drift off. But with regular practice, mindfulness meditation actually changes the brain strengthening the areas associated with joy and relaxation, and weakening those involved in negativity and stress.

Findings suggestive of autonomic relaxation during meditation have been widely reported (Walton et al., 1995; Young et al., 1998). Anxiety is most often used to describe an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry (Spielberger, 1980). The topic most frequently examined in studies on relaxation is trait anxiety. Trait anxiety refers to the general tendency to be anxious as a personality trait, which differs from state anxiety, which refers to the degree of anxiety at a particular moment (Epply et al., 1989; Spielberger, 1980).

A previous study showed that proficient meditators demonstrated increased autonomic activation during meditation while inexperienced meditators demonstrated autonomic relaxation (Corby et al., 1978). It was also reported that certain individuals, namely the psychologically 'healthy' and those with a capacity for relaxed absorbed attention, appeared to be more favourably disposed to meditation (Delmonte, 1984). However, it is not clear whether prospective meditators as a group already possessed these characteristics, or whether the state effects of meditation practice eventually generalize to become traits. In this study, all the subjects were mentally and physically healthy adults who had not previously practiced any form of meditation.

Development of greater awareness of and non-reactivity to intero and exteroceptive sensory stimuli during formal Vipassana / mindfulness meditation is hypothesized to enhance self-awareness such that selective adaptive responding is facilitated at the expense of automated
non-adaptive reactions, thereby promoting more successful management of stressful life situations (Lutz et al., 2008; Segal et al., 2002).

Meditation has been successfully shown to decrease psychosocial stress (Castillo-Richmond et al., 2000). High psychosocial stress causes brain regions involved in memory and emotions, such as the hippocampus, amygdala, and prefrontal cortex, to undergo structural remodelling, with the result that memory is impaired and anxiety and aggression are increased (McEwen, 2006). The stress response is a normal response to prepare for emergency situations. However, if the system is not allowed to recover from stressful experiences, then the body becomes sensitized to stress. The stress response may not turn off or it may get triggered by mild experiences (McEwen, 2006).

Meditation practice is reported to decrease effects of previous stressful experiences and to help an individual function better in stressful situations. Meditation practice is characterized by 1) lower sympathetic tone 2) higher parasympathetic tone, as reflected in amplitude of the high frequency component of heart rate variability, also called respiratory sinus arrhythmia and 3) higher levels of frontal EEG alpha coherence (8-12 Hz) (Travis et al., 2002).

Basic and clinical research has documented the effectiveness of practice of the Transcendental Meditation technique in decreasing anxiety (Eppley et al., 1989), enhancing self-actualization (Alexander et al., 1991). Transcendental consciousness was distinguished by autonomic orienting at the onset of 10-40-s-long apneustic breathing periods (slow, continuous inhalation).

Davidson, were prompted by studies like those above to look further at the suggested enhancement of attentive ability, they tested four groups: control (interested in meditation, but not meditators), beginners (practicing for 1 month or less), short-term (< 24 months), and long-term (> 24 months), on the Tellegen Absorption Scale (TAS) and the State-Trait Anxiety Inventory (STAI). Meditation practices of the subjects varied, including TM, Zen, and focused
attention on breathing. Data revealed highly significant changes in absorption measures on the TAS that are consistent with a training effect and highly significant decreases on the STAI as a function of the length of time meditating (Davidson, 1984).

Though there is very little research which has combined meditation therapy with conventional treatment in anxiety disorders, there is still a lack of reviews that provide substantial evidence on the effectiveness of meditation therapy programs, both for short-term and long-term effects and for acceptability in terms of practicality, feasibility, difficulty and concerns about the adverse effects (Krisananprakornkit et al., 2006).

A recent meta-analysis (Chiesa and Serretti, 2009) found a significant reduction in stress levels in addition to a significant improvement in spirituality levels in those who attended MBSR programmes compared to waiting list controls. Furthermore, MBSR significantly reduced many parameters, including depression, anxiety score (Astin, 1997) and rumination (Jain et al., 2007), and enhanced interpersonal sensitivity (Shapiro et al., 2007) and also more adaptive copying strategies and self-compassion.

Mindfulness were directly related to better sleep quality at the end of MM meditation, Tiredness, Negative Arousal, Relaxation, and Perceived Stress mediated the effect of increased mindfulness on improved sleep (Karen, 2010). Once sleep improves the anxiety level also decreases.

(Apter and Svebak, 1990) have identified two types of stress in reversal theory: 'tension-stress' occurs when there is a discrepancy between preferred and actual level of arousal; and 'effort-stress' occurs as a consequence of attempting to reduce tension-stress. It should be clear that the intervention options for performance enhancement are not merely concerned with increasing or decreasing arousal levels. Instead, they include inducing reversals from paratelic to telic in the case of tension-stress caused by low arousal, and from telic to paratelic when tension-
stress is caused by high arousal. (Kerr, 1987) has suggested that it is possible for sports performers to induce the necessary reversals via a cognitive restructuring or imagery strategy.

2.5.5 Studies on Meditation Duration

Although a few researchers have examined the effectiveness of brief meditation interventions, none have implemented a training as brief as the one described here. For example, (Kingston et al., 2007) used a 6-session, 3-week meditation intervention and found increases in pain tolerance with a cold pressor task.

(Lane et al, 2009) reported that a 1-month mindfulness meditation intervention increased positive mood and reduced distress. Similarly, (Jain et al., 2007) implemented a 1-month meditation program and found a reduction in negative mood states and rumination in meditators when compared with control subjects.

Reductions in state anxiety and increases in mindfulness provide behavioral evidence that 3 days of mental training can promote a mindful state, which, in turn, may attenuate the subjective experience of pain (Grant., 2009).

(Tang et al., 2007) reported that 5 days of Integrative Body Mind Training improved mood and cognitive processes. However, Integrative Body Mind Training incorporates various techniques (e.g. mindfulness, guided-imagery, music therapy) leaving it hard to decipher if mindfulness was the mechanism underlying improvements.

A recent study Zeidan et al., (2009) found that 3 days of MM training was effective at reducing pain ratings and sensitivity, as well as anxiety scores when compared to baseline and other cognitive manipulations, such as relaxation and a math distracter task. A similar training regimen improved mood and reduced heart rate when compared to a sham MM and control group.
Several meaningful results have been observed. First of all even moderately brief mindfulness training such as an 8 week meditation program or a short term intensive retreat could improve sustained and particularly selective and executive attention as well as attention switching in subjects with no prior meditation experience. Of note, reviewed findings provide preliminary evidence for this. First of all, when mindfulness training was investigated by means of properly delivered meditation programs, significant benefits were observed following MMP in comparison with no treatment (Chambers, et al., 2008; Jha, et al., 2007) or relaxation conditions (Tang, et al., 2007).

A second thought of our review was that long term MMP could be associated with further improvements on attentional measures mentioned above as well as with the development of unfocused sustained attention characterized by a more distributed attentional focus in comparison with early stages of practice. A number of case-control studies comparing expert mindfulness meditators with concentrative meditators and non meditators reported meaningful results in this direction. First of all, the majority of reviewed studies found significantly higher attentional abilities in long term mindfulness meditators as compared with matched controls on different domains of attention (Hodgins and Adair, 2010; Van den Hurk, et al., 2010).

The evidences that support the use of Shavasana training of 10min (only once) for 4 weeks in relaxation therapy, supine cold pressor testing demonstrated statistically significant blunting of sympathetic responses. It is suggested that future researchers include variables such as heart rate variability and muscle sympathetic nerve activity, to be able to comment more precisely on the sympathetic drive or load on the heart (Geetanjali et al., 2007). If so 20 minutes meditation can show the improvement.

Intensive short-term meditation training improves stimulus detection (Brown et al., 1984), experienced meditators show greater improvement in stimulus detection during intensive
retreat relative to new and non-meditators (Jha et al., 2007). Research studies on the biological and clinical concomitants of MM are providing increasing evidence about the short and long term changes that occur in mindfulness meditators (Cahn and Polich, 2006). Second, to date, there is only little evidence of the long term effects of MM. An investigation of long term effects is important: first, because there is some evidence that most MM practitioners continue to meditate after the programme (Miller et al. 1995); second, to exclude possible short-term placebo effects, and third, to link neurological changes observed in long-term meditators to trait clinical changes (as, for example, long-term prevention of depression relapses) (Chiesa et al., 2010).

In this study we examined whether 4 weeks (20 min/day) of Mindfulness Meditations training affects physiological markers on relaxation and performance enhancement.

2.5.6 Studies on Follow-Up Effects of Meditation

Crocker et al., (1988) utilized a stress-management intervention including meditation and in-practice integration of coping skills to develop the capacity to focus on performance, attend in the moment, and cope with experienced emotion for elite volleyball players. In this study, while no reductions in competitive anxiety and minimal changes in actual negative cognitions were noted, there were significant competitive performance improvements, and these improvements were maintained at 6-month follow-up.

Raskin conducted a controlled study comparing muscle biofeedback, transcendental mediation, and relaxation therapy. The study consisted of a six-week baseline period, six weeks of treatment, a six-week post treatment observation period, and later follow-up (Raskin, 1980).

Experience in conducting MBSR groups suggests that there are at least three phases of development that many participants experience during the course of 8 weeks (Kabat-Zinn, 1982) although this has yet to be formally assessed via clinical research. Initially, most people enroll in the program because they hope for specific health benefits such as pain reduction or being able to
relax. But in our study we are dealing with sports persons without illness many patients referred to the MBSR program suffer from disuse atrophy, this also supports to reduce the duration.

2.5.7 Meditation Physiology

Meditation practices are embedded in different cultures, worldviews, and traditions, which confounds discussions between meditation traditions. Neuroscience provides the language of brain functioning to discuss meditation practices. Brain patterns reflect the cognitive processes used in meditation practices (attention, feeling, reasoning, visualization), the way these processes are used (minimal- to highly-controlled cognitive processing), and the objects of meditation (thoughts, images, emotions, breath). Thus, brain patterns could provide an objective "language" to discuss procedures and experiences resulting from different meditation practices (Fred Travis, 2010).

A study using fMRI demonstrated that experienced Vipassana meditators during meditation evinced higher levels of hemodynamic activity in rostral anterior cingulate cortex and medial prefrontal cortex relative to novice meditators (Holzel et al., 2007). Moreover, experienced meditators in the mindfulness-based traditions have consistently demonstrated higher levels of attention-related activity in prefrontal areas. This outcome is consistent with findings that selective attentional control is increased in meditative practice partly through the recruitment of prefrontal cortical activity (Cahn and Polich, 2006).

Several investigations of mindfulness meditation practice have reported increased functioning of attentional measures such as executive attention (Tang et al., 2007), visual sensitivity (Brown, 2007), as well as endogenous orienting and exogenous alerting-related functions (Jha et al., 2007).

These attention-related meditation effects may stem from physical changes induced in Vipassana meditators, who have increased cortical thickness in regions related to auditory,
visual, somatosensory, and interoceptive processing (Lazar et al., 2005). The strongest of these effects have been observed in the right anterior insula, an area related to bodily attention and increased visceral awareness (Critchley et al., 2004). Assessment of Zen meditators compared to controls yielded similar findings (Pagnoni and Cekic, 2007).

The meditative state may therefore induce a brain activity with increased baseline activation of frontal attentional circuits wherein these circuits also are less responsive to unexpected attention-demanding stimuli. Thus, as a state effect the frontal attentional network may be directed inward and become less reactive to external stimuli, whereas long term meditation practice may be related to trait effects reflecting the purposeful engagement of attention that preserves neural sources of attentional and interoceptive processing (Lazar et al., 2005; Pagnoni and Cekic, 2007).

There is higher frontal alpha-1 coherence; this random assignment study reported EEG patterns in eight subjects during Transcendental Meditation practice after 2 weeks practice compared to eyes-closed rest in seven subjects who rested twice a day for the 2 week period (Dillbeck and Bronson, 1981).

People who have undergone extensive meditation training have shown improvements on cognitive performance (Cahn and Polich, 2006) and mood (Davidson et al., 2003). Long-term meditation practice has been found to enhance attentional (Jha et al., 2007) and visuospatial processes (Kozhevnikov et al., 2009). For example, 3-months of intensive meditation training (10-12 h/day) improved the ability to sustain attention during a dichotic listening task as evidenced by faster reaction times in response to a deviant tone, and reduced attentional blink responses when compared to controls (Lutz et al., 2008). (Moore and Malinowski, 2009) found that self-reported mindfulness was positively correlated with sustained attention in experienced Buddhist meditation practitioners, when compared to controls. Additionally, long-term meditation practice has been found to reduce attentional blink in older adults when compared to
age-matched and younger adults (van Leeuwen et al., 2009). In a study employing neuroimaging, extensive meditation training heightened activation in executive attention networks that was correlated with improvements in sustained attention and error monitoring. These findings provide growing evidence of mindfulness meditation's (MM) promotion of higher-order cognitive processing; specifically facets of conflict monitoring and cognitive control processes.

MM is based on promoting a balance between a relaxed and vigilant state of mind (Wallace, 2006). The ability to self-regulate emotions has been found to be a key component in enhancing cognition (Moore and Malinowski, 2009). It is possible that the calming effects of MM combined with the increased capacity to focus on the present improved cognitive performance after brief training. MM training enhances present moment awareness by teaching participants to notice subtle distractions (feelings; thoughts; emotions) while repeatedly bringing attention back to the meditation object. This process can promote attentional stability (Epel et al., 2009; Wallace, 2006).

Some of these cognitive benefits have recently been reported with experienced meditators (Kozhevakov et al., 2009). In fact, (Brefczynski-Lewis, 2007) found that adept and novice meditators exhibited overlapping higher order attention-related neural activations. Similarly, 5 days of Integrative Body Mind Training effectively increased neural activity in the executive attention network which was correlated with better performance on attentional tasks (Tang et al., 2009).

Focused Attentional meditation compared with a rest condition, was associated with activation in multiple brain regions involved in monitoring, such as dorsolateral prefrontal cortex (DLPFC), attentional orienting (e.g., the superior frontal sulcus and intraparietal sulcus) and
engaging attention (visual cortex). The meditation-related activation patterns depended on the level of expertise of the meditation practitioners.

(Chiesa et al., 2010) Mindfulness meditation practices (MMPs) are a subgroup of meditation practices which are receiving growing attention (Chiesa and Serretti, 2010). This paper reviewed current evidence about the effects of MMPs on objective measures of cognitive functions. Overall, reviewed studies suggested that early phases of mindfulness training, which are more concerned with the development of focused attention, could be associated with significant improvements in selective and executive attention whereas following phases, which are characterized by an open monitoring of internal and external stimuli, could be mainly associated with improved unfocused sustained attention abilities. Additionally, MMPs could enhance working memory capacity and some executive functions (Chiesa et al., 2010).

The state of mindfulness has frequently been described as a state of "presence of mind" which concerns a clear awareness of one's inner and outer worlds, including thoughts, sensations, emotions, actions or surroundings as they exist at any given moment (Gunaratana, 1993).

Numerous theories have attempted to identify subcomponents of attention. One of the most consistent theoretical frameworks of attention suggests that it consists of three functionally distinct neural networks: alerting (also referred to as sustained attention or vigilance), orienting (or selective attention or concentration) and executive attention (or divided attention or conflict monitoring) (McDowd, 2007; Posner and Rothbart, 2007). According to this model, alerting consists of achieving and maintaining a vigilant or alert state of preparedness, orienting regulates and limits attention to a subset of possible sensorial inputs, and executive attention prioritizes among competing thoughts, feelings, and responses (Posner and Rothbart, 2007).
In addition to these subsets of attention, the model suggested by (Mirsky et al., 1991) also includes shift of attention/attention switching referred to as 'the ability to change attentive focus in a flexible and adaptive manner”

Shooting sports needs higher order cognitive abilities that facilitate the flexible modification of thought and behavior in front of novel cognitive or environmental demands. Executive functions include a number of abilities such as problem solving, planning, concept formation and decision making, attention and working memory that have been recently distinguished from emotional/motivational executive functions (Ardila, 2008).

The practice of focused attention meditations involves the development of at least four different faculties, including sustained attention to a target object, monitoring faculty (so as to detect mind wandering), the ability to disengage from a distracting object without further involvement (attention switching), and the ability to redirect focus promptly to the chosen object (selective attention) (Lutz, et al., 2008).

An alternative second pathway by which meditation could decrease visual perceptual bias is even more direct and concrete. Although meditation techniques differ (Lutz, et al., 2008), they have in common the monitoring and regulation of attention, which is central to visual perception. Thus, meditation could improve perception quite directly, by heightening attentional processes, and also indirectly, by altering the self-functioning that contributes to perceptual bias.

Meditation also enhances specific attentional measures; for example, it improves short-term attention switching (Chambers et al., 2008), decreases Stroop interference and improves concentration (Moore and Malinowski, 2009), changes brain-resource allocation, reducing the "attentional-blink" refractory period and is associated with the absence of expected age-related
increases in attentional blink (van Leeuwen et al., 2009). The above studies examined perception during or immediately after meditation.

Mindfulness meditators have been reported to show superior attentional performance, especially in relationship to unexpected stimuli, compared to concentrative meditators and non-meditators (Jha et al. 2007). Improvements in attentional levels, then, could be related to improvements in psychological outcomes (Chambers et al., 2008). Selective attention task is necessary for shooting performance though findings suggesting that meditation experience seems to be related to enhanced selective attention abilities.

2.5.8 Meditation on Cortisol

Cortisol, the primary stress hormone secreted from the adrenals, is known to have immunosuppressive effects (Spiegel et al., 1998). Its hyper secretion may also result in depressed mood (Wolkowitz, 1994). It is speculated that these abnormal circadian rhythms of cortisol secretion represent compromised hypothalamic-pituitary-adrenal (HPA) axis functioning, which may be responsible for the earlier mortality.

(Werner et al., 1986) reported long-term endocrinologic changes in thyroid stimulating hormone, thyroid hormone, growth hormone, prolactin and cortisol in subjects practicing transcendental meditation.

(Walton et al., 1986) found low concentrations of the metabolite vanillylmandelic acid and lower blood levels of cortisol and aldosterone in TM practitioners, in comparison with nonpracticing subjects.

(Ratree et al., 1991) The results of the study indicated that Buddhist meditational practice produces reductions in serum Cortisol level, blood pressure, pulse rate, vital capacity, tidal volume, maximal voluntary ventilation and reaction time. The serum total protein level increased
after 6 weeks of meditation. The Cortisol level has been proposed to be an index of stress in physiology. Therefore, Buddhist meditation may reduce some stress in a way similar to transcendental meditation. In experimental group A, the subjects claimed that they were in a state of tranquility every time during their practice and in this group the serum Cortisol showed the lowest levels. In experimental group B, who were able to encounter the state of tranquility some times but not every time, the serum cortisol decreased after 3 weeks of practice, but increased somewhat after 6 weeks of practice? This rise could be due to shortening of the period of practice from 4 hours to 2 hours a day.

(Linda et al., 2004), investigated the relationships between a mindfulness-based stress reduction (MBSR) meditation program for early stage breast and prostate cancer patients and quality of life, mood states, stress symptoms, and levels of cortisol, dehydroepiandrosterone-sulfate (DHEAS) and melatonin. The eight-week MBSR program that incorporated relaxation, meditation, gentle yoga, and daily home practice. Demographic and health behavior variables, quality of life, mood, stress, and the hormone measures of salivary cortisol (assessed three times/day), plasma DHEAS, and salivary melatonin were assessed pre- and post-intervention. Significant improvements were seen in overall quality of life, symptoms of stress, and sleep quality, but these improvements were not significantly correlated with the degree of program. Improvements in quality of life were associated with decreases in afternoon cortisol levels, but not with morning or evening levels, resulted in possibly beneficial changes in hypothalamic-pituitary-adrenal (HPA) axis functioning.

Meditation has been shown to decrease cortisol levels in populations of healthy volunteers (MacLean et al., 1994; Sudsuang et al., 1991), but the effect of meditation training program in pre competition stress and release of cortisol levels has not previously been evaluated
in Sports population. However, there has been some investigation of the effects of psychosocial intervention on cortisol levels in normal and patient population.

(Kirschbaum and Hellhammer, 1994), in the study salivary cortisol measurement was used, and has been shown to accurately reflect blood levels.

A study of healthy long-term meditation practitioners found higher levels of Dehydroepiandrosterone sulfate DHEAS and lower levels of cortisol compared to healthy controls (Walton et al., 1995). Higher levels of DHEAS have been associated with enhanced immune function and mood in humans (Morales et al., 1994).

(Tang et al., 2007) randomly assigned Chinese students to 5 days of either intensive meditation or relaxation training. After 5 days, participants who meditated had better attentional processing on alerting, orienting, and executive function measures as well as better mood, lower cortisol, and better immune function, allowing to conclude that randomly assigned short-term intensive meditation causes immediate benefits.

2.5.9 Meditation on Heart Rate Variability

Increased the low frequency (LF) component of HRV, presumably due to sympathetic activation reflecting mental stress (Pagani et al., 1991)

During guided relaxation, there was a reduction in the power of the low-frequency (LF) component of the heart rate variability spectrum and an increase in the power of the high-frequency (HF) component, which suggested a reduction in sympathetic nervous system activity. Further analysis revealed that subjects who had a baseline ratio of LF/HF greater than 0.5 demonstrated a significant reduction in the ratio after guided relaxation; whereas, subjects with a baseline ratio less than or equal to 0.5 did not show this change. Yoga-based guided relaxation decreased sympathetic nervous system activity depending on subject's baseline levels (Vempati
and Telles, 2002). Any form of stress, physical or mental, if continued for prolonged periods, results in sympathetic dominance as is evidenced by a gradual rise in BP, heart rate, respiratory changes, increased metabolic activity, gastro-intestinal changes and endocrinal disturbances. Meditative practices gradually diminish sympathetic dominance, resulting in better balance between sympathetic and parasympathetic components (Anand, 1991).

Among HRV indices, LF/HF significantly decreased while nuHF significantly increased during meditation. Therefore, HRV suggest that the meditative state induced in this study was a specific mental state characterized by the coexistence of relaxation and internalized attention (T Murata et al., 2004).

Studies have found HF-HRV reflections of vagal tone to be lower in depressed psychiatric patients compared with controls; the patients showed autonomic function imbalance as indicated by higher low-frequency HRV (LF-HRV) and ratio of low to high frequency HRV (LF/HF), reduced HF-HRV and lower BRS. This dysfunctional pattern was associated with higher HR and BP. HF-HRV has also been related to depressed mood during stressors (Hughes and Stoney, 2000).

Heart rate variability (HRV) has been established as a non-invasive tool to study cardiac autonomic activity. Concerning HRV indices, decreases in nuLF and LF/HF and an increase in nuHF were observed during meditation, indicating an inhibition of sympathetic tone and an activation of parasympathetic tone, respectively.

HRV is markedly influenced by the breathing pattern and posture (Sakakibara et al., 1994). In this study, since the breathing rhythm was made constant and a common posture (supine) was used.
It is theoretically associated with dopaminergic activity (Cloninger, 1987; Herbst et al., 2000; Suhara et al., 2001; Yasuno et al., 2001). The results in this study are supported by enhanced dopaminergic activity during meditation (Kjaer et al., 2002).

2.5.10 Research and Statistics on the Benefits of Meditation

In over 1500 separate studies since the early 1930s, meditation has been clearly shown to offer a wide variety of benefits. The following citations from recent sources highlight many of these results;

1. D. S. Khalsa, and C. Stauth, 2001; Meditating 45 year old women and men had on average, respectively, 47% and 23% more DHEA (the youth related hormone) than non-meditators, this helps decrease stress, heighten memory, preserve sexual function, and control weight.

2. Meditation creates a unique state, in which the metabolism is in an even deeper state of rest than during sleep. During sleep, oxygen consumption drops by 8 percent, but during meditation, it drops by 10 to 20 percent.

3. The calming hormones melatonin and serotonin are increased by meditation and the stress hormone cortisol is decreased.

4. Meditation that reduces blood lactate, a marker of stress and anxiety.

5. The breath rate and plasma lactate decreases and the basal skin resistance increases significantly more during meditation than during eyes-closed rest.

6. Experiments conducted by Dr H Benson, 1968 of Harvard University into meditation techniques established that the techniques had a very real effect on reducing stress - direct effects included slowed heartbeat and breathing, reduced oxygen consumption and increased skin resistance. "The Relaxation Response". 
7. Recent research has shown that meditation is good for the brain. It appears to increase grey matter, improve the immune system, reduce stress and promote a sense of wellbeing. (New York Times, May 8, 2007).

8. A study by neuroscientist Sara Lazar (who leads Meditation research at Harvard Medical School) showed that the part of the brain i.e. the cerebral cortex (critical in decision making and working memory) was thicker in people who meditated for as little as 40 minutes a day, compared with people who did not. It is possible that meditation may protect against age-related thinning of this part of the brain.

9. Practicing meditation may play an important role in controlling certain risk factors for heart disease…practice for 20 minutes a day has a positive, measurable effect on the build up of fatty deposits in arteries or atherosclerosis…just a small reduction could reduce the risk of heart attack by 11 % and reduce the risk of stroke by 15%. CNN, July 2000 and referencing the March edition of the journal Stroke.

10. Eighty percent of hypertensive patients have lowered blood pressure and decreased medications - 16% are able to discontinue all of their medications. These results lasted at least three years. (Journal of Cardiopulmonary Rehabilitation, 1989)

11. A study shows that meditation can help produce antibodies against illness and also lift your spirits. Researchers say biological effects seen in the study are long lasting up to four months after the end of meditation training. Psychosomatic Medicine 2003.

12. One hundred percent of insomnia patients reported improved sleep and 91% either eliminated or reduced the use of sleeping medication. (The American Journal of Medicine, 1996).

14. According to a study of the journal PloS Biology, meditation can also affect attention. The study's lead author, Richard Davidson, professor of psychology and psychiatry, University of Wisconsin said this was the first study to examine how meditation affects attention, which shows that attention is a flexible, trainable skill which can change with practice.

15. Meditation decreases oxygen consumption, heart rate, respiratory rate, and blood pressure, and increases the intensity of alpha, theta, and delta brain waves the opposite of the physiological changes that occur during stress. (Herbert Benson, M.D. Harvard Medical School, author of The Relaxation Response).

16. Meditation practiced regularly, can help to lower stress and blood pressure and enhance our state of awareness. Meditation helps release stress and fatigue, rest the body, and thus allow it to heal naturally by reducing the toxic chemistries of stress.” (Lance Secretan, Industry Week, March 2001).

17. Stress reduction techniques, such as meditation, muscle relaxation training, and yoga should be among the daily activities of older people. Studies show that chronic stress alters brain structure and can reduce the body's ability to maintain normal physiologic and cognitive function.” (Journal of the American Medical Association).

18. Meditators were less anxious and neurotic, more spontaneous, independent, self-confident, empathetic, and less fearful of death. (Atlantic Monthly, May, 1991).

19. 75% of long-term insomniacs who have been trained in relaxation and meditation can fall asleep within 20 minutes of going to bed. Dr. Gregg Jacobs, Psychologist, Harvard.
20. “Recent research has looked at precisely what happens during meditation that allows it to cause these positive physical changes... A group of people who had meditated for four months [were found to produce] less of the stress hormone cortisol. They were therefore better able to adapt to stress in their lives, no matter what their circumstances were.” (Psychology Today, May 2001).

21. A study showed that plasma cortisol, a stress hormone, decreased during meditation, whereas it did not change significantly in controlled subjects during ordinary relaxation. (Hormones and Behavior, 1978).

22. “The three-month study of managers and employees who regularly practiced meditation in [Puritan-Bennett Corporation] showed that meditation practitioners displayed more relaxed physiological functioning, greater reduction in anxiety, and reduced tension on the job, when compared to control subjects with similar job positions in the same companies.” (Anxiety, Stress and Coping International Journal, 1993).

23. Women with severe PMS showed a 58% improvement in their symptoms after five months of daily meditation. (Health, September, 1995).

24. Relaxation therapies are effective in treating chronic pain, and can markedly ease the pain of low back problems, arthritis, and headaches. (National Institutes of Health, 1996).

25. Twenty out of twenty-two anxiety-prone people showed a 60% improvement in anxiety levels following an eight week course in meditation. (University of Massachusetts).

26. Meditation may slow aging. A study found that people who had been meditating for more than five years were physiologically 12 to 15 years younger than non-meditators. (International Journal of Neuroscience, 1982).
2.6 **Salivary Cortisol**

Although researchers have incorporated both psychological and physiological measures of anxiety, few have examined this in conjunction with the effect of anxiety on performance. The effect of pre-competition anxiety on athletic performance is unclear as previous research has yielded inconsistent results. Very few researchers have used psychophysiological markers to examine pre-competition anxiety.

2.6.1 **Cortisol in Sports Competition**

Cortisol is a hormonal response to acute stress and has been measured to be higher before competition than at resting conditions (Salvador et al., 2003) (Table.2.1).

In the majority of competitions, an active pattern of responses would increase the probability of obtaining victory. On the contrary, a passive pattern, characterized by negative mood and C increases together with an insufficient T and SNS activation, would lead to a greater probability of defeat. Status, previous experience, proximal context, expectations of outcome, among others, affects the activation of one response pattern or another. With regard to C levels, an anticipatory increase would imply an adaptive response, especially if a high energetic cost is foreseeable in the near future, but it would be accompanied by a posterior reduction. Elevated levels later, especially long after the end of the competition, seem to be related to more distress and an inadequate interruption of the response (Salvador and Costa, 2009) (Table.2.2).

The body produces varying amounts of Cortisol depending on the situation. Some researchers have found that athletes produce higher levels of Cortisol before games than before non-competition situations (Filaire et al., 2007; Filaire et al., 2001; Haneishi et al., 2007; Salvador et al., 2003). Similarly, Filaire et al., (2007) found that Cortisol levels were significantly higher immediately prior to competition than on resting days for elite, male
paragliders. Conversely, some researchers have found no difference between baseline Cortisol levels and pre-competition Cortisol levels (Doan et al., 2007; Gonzalez-Bono et al., 1999).

Hodgson et al., (2009) had done a study on impact of subjective anxiety and self-confidence levels by measuring plasma cortisol concentrations and the relationship between subjective states and cortisol during rock climbing was studied. Participants were tested in three climbing conditions that were designed to invoke low, moderate and high physical and mental stress. Plasma cortisol concentrations were collected before and after climbing and participants reported subjective anxiety and self-confidence states for each climb. Repeated measures analysis of variance showed significant differences between conditions for somatic anxiety, self-confidence and change in plasma cortisol concentration.

**Table 2.1: Studies on impact of sports competitions on hormonal variables in men**

<table>
<thead>
<tr>
<th>Sports contests</th>
<th>Men (n)</th>
<th>Differences between W and L in hormones</th>
<th>Time interval considered (Samples compared)</th>
<th>Statistics</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tennis matches (Doubles)</td>
<td>8</td>
<td>T : ↑W, ↓L</td>
<td>1–2 post</td>
<td>(Residual values) binomial test</td>
<td>Mazur A et.al.,1980</td>
</tr>
<tr>
<td>Tennis matches (singles)</td>
<td>6 (×6 meets)</td>
<td>Tsal: ↑W, ↓L</td>
<td>15 min pre to immediately after the match</td>
<td>Absolute differences (t-test, one-tailed)</td>
<td>Booth A et.al.,1989</td>
</tr>
<tr>
<td>Wrestling matches</td>
<td>15</td>
<td>∆T: W&gt;L; C:W&gt;L</td>
<td>10 min pre to 10 min post</td>
<td>Percent changes Duncan’s test</td>
<td>Elias M,1981</td>
</tr>
<tr>
<td>Wrestling competition</td>
<td>15</td>
<td>Tsal: n.s.; Csal: n.s.</td>
<td>Resting day, two-day competition (8:30, 11:30, 15, 17:30, 19:30) and 8 days after(17:30)</td>
<td>Wilcoxon test</td>
<td>Passelergue P, et.al.,1999</td>
</tr>
<tr>
<td>Judo combat</td>
<td>14</td>
<td>ΔT: n.s.; ΔC: n.s.</td>
<td>10 min pre to 45 min post</td>
<td>Percent changes (t-test, two-tailed)</td>
<td>Salvador A, et.al.,1987</td>
</tr>
<tr>
<td>Judo combat</td>
<td>17</td>
<td>ΔT: n.s.; ΔC: n.s.</td>
<td>10 min pre to 45 min post</td>
<td>Percent changes (t-test, two-tailed)</td>
<td>Salvador A, et.al.,1990</td>
</tr>
<tr>
<td>Judo combat</td>
<td>28</td>
<td>Tand PRL: n.s., C: W&gt;L</td>
<td>10 min pre to 10 min post</td>
<td>ANOVAs of repeated measures</td>
<td>Suay F, et.al.,1999</td>
</tr>
<tr>
<td>Judo competition</td>
<td>12</td>
<td>Tsal: n.s.; Csal: n.s.</td>
<td>2 pre- (60 and 20 min) and 3 postsamples</td>
<td>ANCOVAs</td>
<td>Serrano MA, et.al.,2000</td>
</tr>
</tbody>
</table>
Regional Judo Championsh ip 18 Tsal: W < L; Csal: n.s 3 fixed time points: 8:00, 12:00 and 17:00 h (Competition between 12:00 and 17:00) ANOVAs of repeated measures Filaire E, et.al.,2001

Chess: regional tournament 11 Tsal: ↑W > ↑L 8 samples along 3 days (differences appeared the following morning) ANOVAs of repeated measures, (t-test) Mazur A, et.al.,1992

City tournament 8 Tsal: W > L after the sixth, seventh and final games 3 samples two days a week for 9 weeks ANOVAs of repeated measures, (t-test)

National basketball league 16 Tsal: n.s.; Csal: n.s. 45 min pre to 15 min post ANOVAs of repeated measures Gonza‘lez-Bono E, et.al., 1999

(Salvador, 2005)

(T, levels of testosterone in serum or plasma (if in saliva, Csal); C, levels of cortisol; PRL, levels of prolactin; ∆ T, response or changes in testosterone; ∆ C, response or changes in cortisol; W, winners; L, losers.)

Table 2.2: Studies on impact of sports and laboratory competitions on hormonal and cardiovascular variables, in men and women

<table>
<thead>
<tr>
<th>Studies</th>
<th>N and sex</th>
<th>Experimental situation</th>
<th>Measures and results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sports</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mazur and Lamb (1980)</td>
<td>8 E</td>
<td>Tennis matches (doubles)</td>
<td>T: ↑in W, ↓ in L</td>
</tr>
<tr>
<td>Elias (1981)</td>
<td>15 E</td>
<td>Wrestling matches</td>
<td>T: ↑ in W; C: ↑ in W</td>
</tr>
<tr>
<td>Salvador et al. (1987)</td>
<td>14 E</td>
<td>Judo combat</td>
<td>T: n.s.; C: n.s.</td>
</tr>
<tr>
<td>Campbell et al. (1988)</td>
<td>8 E 4</td>
<td>Wrestling matches, 4 cycloergometry</td>
<td>T: ↑ in L</td>
</tr>
<tr>
<td>Booth et al. (1989)</td>
<td>6 E</td>
<td>Tennis matches (singles) in 6 meets</td>
<td>Tsal: ↑W ↓ in L</td>
</tr>
<tr>
<td>Salvador et al. (1990)</td>
<td>17 E</td>
<td>Judo combat</td>
<td>T: n.s.; C: n.s.</td>
</tr>
<tr>
<td>Mazur et al. (1992)</td>
<td>16 E</td>
<td>(a) Chess tournament</td>
<td>(a) Tsal: ↑ in W&gt; ↑ in L</td>
</tr>
<tr>
<td></td>
<td>8 E</td>
<td>(b) Chess tournament (in 9 meets)</td>
<td>(b) Tsal: W&gt; L after sixth event</td>
</tr>
<tr>
<td>Study</td>
<td>Group</td>
<td>Experiment</td>
<td>Tsal</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------</td>
<td>------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>González-Bono et al. (2000)</td>
<td>16 E</td>
<td>Basketball</td>
<td>n.s.</td>
</tr>
<tr>
<td>Serrano et al. (2000)</td>
<td>12 E</td>
<td>Judo competition</td>
<td>n.s.</td>
</tr>
<tr>
<td>Filaire et al. (2001)</td>
<td>18 E</td>
<td>Judo championship</td>
<td>L &gt; W; n.s.</td>
</tr>
<tr>
<td>Bateup et al. (2002)</td>
<td>17 F</td>
<td>Rugby (in 5 meets)</td>
<td>n.s.; W &lt; L</td>
</tr>
<tr>
<td>Kivlighan et al. (2005)</td>
<td>23 E, 23 F</td>
<td>Rowing ergometer</td>
<td>↑</td>
</tr>
<tr>
<td>Kivlighan and Granger (2006)</td>
<td>21 E, 21 F</td>
<td>Rowing ergometer</td>
<td>↑</td>
</tr>
<tr>
<td>Edwards et al. (2006)</td>
<td>22 E, 18 F</td>
<td>Soccer competition</td>
<td>↑ in E and F</td>
</tr>
<tr>
<td>Laboratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mazur and Lamb (1980)</td>
<td>14 E</td>
<td>Lottery</td>
<td>↑</td>
</tr>
<tr>
<td>Gladue et al. (1989)</td>
<td>39 E</td>
<td>Reaction time</td>
<td>↑ in all task</td>
</tr>
<tr>
<td>McCaul et al. (1992)</td>
<td>28 E, 101 E</td>
<td>Coin toss</td>
<td>↑ in n.s. W</td>
</tr>
<tr>
<td>Mazur et al. (1997)</td>
<td>28 E, 32 F</td>
<td>Tennis video game</td>
<td>n.s.; n.s.</td>
</tr>
<tr>
<td>van Anders and Watson (2007)</td>
<td>37 E, 38 F</td>
<td>Computed vocabulary.</td>
<td>↑ in E, F n.s.</td>
</tr>
<tr>
<td>Ricarte et al. (2001)</td>
<td>13 E, 53 F</td>
<td>Role-playing game</td>
<td>↑ in E and F</td>
</tr>
</tbody>
</table>

(Salvador and Costa, 2009)

(Doan et al., 2007) found a strong positive correlation between somatic anxiety and pre-golf tournament Cortisol levels. As was hypothesized, Cortisol was negatively correlated with performance. This finding indicates that absolute values of Cortisol concentration are related to performance. Similarly, Cortisol was found to be negatively correlated with 36-hole golf performance.

Additionally, (Haneishi et al., 2007) found a positive relationship between Cortisol and cognitive anxiety, but only for starting soccer players before practice. Although psychological and physiological factors seem to contribute to the overall pre-competition stress response, their relationship to performance has not been adequately studied.

(Abbreviations: T = plasma testosterone, Tsal = salivary testosterone, C = plasma cortisol, Csal = salivary cortisol, PRL: prolactin, W= winners, L = losers, E = men, F = women.)
In a golf study, (McKay et al., 1997) found that neither the CSAI-2 nor Cortisol concentration were significant predictors of performance. However, (Filaire et al., 2009) found that tennis players who lost a single match exhibited higher pre-competition Cortisol than those who won.

In a study salivary samples were collected to assess Cortisol levels, Baseline Cortisol was established on a non-practice, noncompetition day three days (for males) or four days (for females) prior to the basketball game, and pre-competition Cortisol was established one hour and 30 minutes prior to one regular season basketball game. They found, cognitive and somatic anxiety intensity was higher, and self-confidence was lower, pre-competition than at baseline conditions. The results support previous findings that athletes are more anxious before games than during off days, pre-competition Cortisol concentrations were positively correlated with somatic anxiety intensity (Filaire et al., 2009). Because Cortisol is secreted as a result of a threatening stimulus, and sports competition is considered an anxiety-arousing situation (Salvador et al., 2003).

(Eubank et al., 1997) found that elite canoeists who viewed pre-competition anxiety as facilitative to performance exhibited less of an increase in Cortisol concentration from 2 to 1 hour before the event than those who perceived anxiety as debilitative. Unfortunately, the researchers did not then incorporate the effect of such anxiety constructs on actual performance.

In an initial study, (Mazur and Lamb, 1980) concluded that the pattern in T changes was different depending on the outcome, with winners showing significant T increases and losers displaying obvious decreases, when values obtained 1 to 2 h after tennis matches with a clear victory were compared (binomial test). Some time later, it was reported that subjects winning a wrestling match showed significantly greater increases than losers when percent changes
between T levels seen 10 min before and 10 min after the match were compared; winners also showed significantly greater levels of C than losers (Elias, 1981).

When it is compared T and C changes (percent changes) experienced by young male judo competitors in response to a judo combat, non-significant differences were found; blood samples were taken 10 and 45 min after the fight. However, when we grouped subjects depending on whether they belonged to the Autonomic Team (higher rank) or not, significant differences in the T response appeared (Salvador et al., 1987).

Studies investigating the neuroendocrine response to competitions have also mainly focused on the activity of the HPA. Generally, a rise in cortisol secretion has been found in response to a competition. Filaire and colleagues, for example, found an anticipatory rise in cortisol in female gymnasts during weeks leading up to a competition as compared with levels observed in a control group (Filaire et al., 1999).

In several well-designed studies, Rohleder and co-workers also found an anticipatory increase prior to dancing contests (Rohleder et al., 2007). They concluded that sport competitions serve as real life stressor to activate the HPA. Moreover, they discovered similar increases in cortisol across several competitions, which they interpreted as a lack of habituation of the HPA activation to competitions. Also potential moderators have been identified such as the directional interpretation of anxiety symptoms. It has been argued that not the intensity of anxiety perceptions per se but rather their interpretation as being debilitating to performance constitutes the anxiety response (Jones and Swain, 1995).

Eubank et al., (1997), for example, found more elevated cortisol and competitive anxiety responses in canoeists categorized as "debilitators" before a competition.
The sports category again seemed to be an important, moderating variable. We also considered that this variable involved more than just the experience of 'success', because a different degree of physical fitness and training was involved. There is a vast amount of literature in Sports Medicine that suggests that numerous physiological responses, hormonal responses among them, are different depending on the physical fitness of the individual. Later studies have allowed us to confirm this point (Moya et al., 2001; 2003).

Research findings comparing the physiological and psychological markers of stress have been equivocal. (Filaire et al., 2001) found positive correlations between both cognitive and somatic anxiety and Cortisol levels with judo athletes. These ambiguous findings indicate the need for further research into the correlation between physiological and psychological stress markers.

In a recent study, Loupos et al., (2008) examined the psychophysiological effect of anxiety on swimming performance and determined that only Cortisol (not cognitive or somatic anxiety, or self-confidence) significantly predicted performance. To this end, the relationship between psychophysiological anxiety indicators and performance remains unknown when only anxiety intensity is considered. Anxiety direction may clarify this issue as none of the aforementioned studies utilized the directional subscale of the CSAI-2 to determine the facilitative or debilitative nature of pre-competition anxiety. The directional construct of anxiety has been used to examine the relationship between pre-competition psychology and physiology in only one study.

Salvador (2005), Cortisol response showed a very consistent relationship with negative mood (POMS total score). Since the salivary cortisol assay has been proposed as the method of
choice for assessing adrenocortical function, we investigated further its clinical application in sports performance enhancement.

The results support previous findings that athletes are more anxious before games than during off days (Filaire et al., 2009). Because Cortisol is secreted as a result of a threatening stimulus, and sports competition is considered an anxiety-arousing situation (Salvador et al., 2003).

Basic neuroscience may help explain why Cortisol impaired shooting performance. Once Cortisol is released by the adrenal gland, some of it migrates to the cognition-relevant hippocampus, a central structure in the functioning of spatial memory and navigation (Fisher, 1989), two tasks that are critical for successful shooting performance. When anxiety increases and an excess of Cortisol binds to brain receptors, hippocampal functioning is impaired, thus decreasing the brain's ability to retain spatial memory (Kellendonk et al., 2002). Since spatial memory and navigation are important for shooting performance, a decrease in those abilities likely results in performance decreases as well.

The neuroendocrine response (i.e. the release of hormones) as part of the physiological stress response has seen a surge in interest in recent years concerning anxiety and stress research in general, and with respect to sport competition in particular (Salvador, 2005; Salvador and Costa, 2009).

Neuroendocrine stress markers include catecholamines such as nor-epinephrine and dopamine as markers of the sympathetic adrenal medullary system, and cortisol as the primary marker of the hypothalamic pituitary adrenal system (HPA) (Katharina et al., 2010).

Studies have generally found a pronounced hormonal response to a competition. So far, mainly the immediate response has been investigated. Much less is known about the temporal
patterning of this specific period of time before a competition. While the psychological response has been investigated as it unfolds over time, the processes of the neuroendocrine response remain understudied. The neuroendocrine response may appear adequate and functional in light of upcoming demands or it may be dysfunctional, even detrimental to health, for example if it is set-off too early or not at all. Furthermore, for the analysis of coping strategies, the correspondence between psychological and neuroendocrine stress needs to be investigated more closely (Katharina et al., 2010).

Thus, the immediate cortisol response to competition appears to be well explored and established. Although changes in cortisol levels are explained with changes in pre-competitive apprehension, the psychological response, however, is rarely assessed as concomitant factor. Also, longitudinal responses to competitive stress have hardly found any attention. With respect to the psychological response to an upcoming competition, for example, studies found an increase in intensity (as well as of frequency) of cognitive, and especially somatic anxiety throughout the week before the actual sport competition. Given that anxiety symptoms increase with proximity to competition, the question arises whether this anticipatory psychological response is accompanied by a similar (early) neuroendocrine stress response. Such associations would be expected according to (Ursin and Eriksen, 2004) integrational theory whereby the physiological stress response is proposed to follow cognitive processes of situational appraisal.

The increase in cortisol may have implications for the sports performance of the individual. Because acute increases in glucocorticoids have been demonstrated to have detrimental effects on human memory (Kirschbaum et al., 1999), the cortisol response to shooting may hinder optimal judgment within the game. Acute psychologic stress produces increased release of catecholamines and pituitary-adrenal hormones (Richter et al., 1996).
Although researchers have incorporated both psychological and physiological measures of anxiety, few have examined this in conjunction with the effect of anxiety on performance. To date, only limited data exist reporting the neuroendocrine response to shooting sports.

Correlations between psychological and physiological measures are rare with only a few researchers taking a psychophysiological approach to the anxiety-performance issue. Interestingly, in this study we have been used highly reliable physiological measures like Salivary Cortisol and heart rate variability to correlate the physiological approach to the anxiety in sports performance.

Basic neuroscience may help explain why Cortisol impaired shooting performance. Once Cortisol is released by the adrenal gland, some of it migrates to the cognition-relevant hippocampus, a central structure in the functioning of spatial memory and navigation (Fisher, 1989), two tasks that are critical for successful shooting performance. When anxiety increases and an excess of Cortisol binds to brain receptors, hippocampal functioning is impaired, thus decreasing the brain's ability to retain spatial memory (Kellendonk et al., 2002). Since spatial memory and navigation are important for shooting performance, a decrease in those abilities likely results in performance decreases as well.

Till date, no researchers have studied anxiety direction and Cortisol predictors of performance. Perhaps researchers may further develop their comprehension of this issue if they integrate psychological and physiological techniques, measure anxiety interpretation, and focus on a single sport.

2.6.1 Cortisol on Stress or Anxiety

The simplistic notion that what "feels" stressful subjectively should trigger cortisol release continues to influence thinking and experimentation. It is an appealing idea that has poor empirical support. There is some evidence that negative emotional states, which are often
generated by stressful psychosocial challenges, can activate the HPA axis (Lovallo and Thomas, 2000); a very prominent feature of stimulated salivary cortisol levels is the large variation in the response magnitude between individuals as well as across different situations or tests. Such variability can be observed with respect to the net cortisol output as well as the time span of hormone secretion after stress. Overall, the identification of mechanisms that determine the regulation and especially dysregulation of free cortisol responses to stress is, particularly in humans, a very challenging task. Since stress and stress-related health impairments have become major problems in human life, investigations into the biological pathways linking stress and disease are of major importance. An extensive phenotyping including salivary cortisol responsivity is essential in order to be able to uncover mechanisms mediating stress-related disorders and to potentially develop new therapeutic strategies in the future.

In humans, stress results from uncontrollable demands, which may trigger changes in physiological, emotional, cognitive, and behavioural states. Two prominent elements of the stress response are the activation of the hypothalamus-pituitary-adrenal (HPA) axis, with an increase in its end product cortisol, and negative emotional reactions, experienced as negative affective states like tension or anger. In the absence of specific physiological challenges, relevant stimulus information is processed in cortical and limbic central nervous system areas before endocrine changes are triggered (Herman et al., 2003). Thus, psychosocial stressors from everyday life, e.g. momentary work-related or social stressors, are expected to trigger both emotional and endocrine stress responses, and the strength of the response associations may depend on individual differences in the processing of emotional information.

A relatively new field of research is the investigation of associations between stressful events and cortisol responses using synchronous measures in a naturalistic design, and making
use of suitable methods to measure cortisol and self-reports synchronously, as well as suitable statistical methods to test the effects of interest.

Stressful events in everyday life seem to have an impact on salivary cortisol; the type of event that is most relevant is unknown. Because a meta-analysis demonstrated the effect of motivated performance situations on cortisol in laboratory situations convincingly (Dickerson and Kemeny, 2004), cortisol responses in everyday life may be expected to be most reliably elicited in motivated performance situations, i.e. tasks. Trait anxiety has been shown to be associated with blunted plasma and salivary cortisol levels during a laboratory public speaking situation (Jezova et al., 2004).

It is generally believed that stress is an important factor in the onset and maintenance of widespread musculoskeletal pain (McFarlane, 2007). Dysfunction of the HPA axis is believed to act as a contributory factor to the development of chronic pain (McBeth et al., 2007). Chronic myalgia is a complex and multifactorial condition whose pathophysiological mechanisms are not fully elucidated. The diagnostic criteria of myalgia in the neck and shoulder area are relatively vague and several more or less specific and partly overlapping diagnoses exist in clinical practice and epidemiological research (Larsson et al., 2007). Mental and social stress is thought to increase the risk of developing a musculoskeletal disorder in the neck/shoulder region (Bongers et al., 2002), making stress responses important to explore for this shooting sports group.

Cortisol is the primary glucocorticoid produced by the hypothalamic-pituitary-adrenocortical (HPA) axis (Figure.2.5), which is part of the human stress-response system. A well-established relation between the activity of the HPA axis (as marked by cortisol) and psychological processes and emotional states makes this system particularly relevant in the study
of socioemotional adjustment. Receptors for cortisol are found throughout the brain, and cortisol affects a number of brain regions (e.g., prefrontal cortex, hypothalamus, hippocampus, amygdala) involved in emotion, learning, and memory (de Kloet and de Wied, 1980).

Cortisol levels increase predictably in response to a number of stressors, including mental, social, physical, and situational challenges. It has also been shown that cortisol levels generally increase in proportion to the intensity of the stimulus and its emotional valence. Therefore, it would be expected, that the more intense the stressor, the greater level of cortisol (Lee et al., 2004).
Figure 2.5: Depicts hypothalamic-pituitary-adrenal/gonadal axes (HPA- Axes)

(ACTH = adrenocorticotropic hormone; CRH = corticotropin releasing hormone; FSH = follicle stimulating hormone; GnRH = gonadotropin releasing hormone; LH = lutenizing hormone)
Acute hypocapnia increases levels of cortisol, insulin, free fatty acids and catecholamines, and is accompanied by psychological symptoms including anxiety, nervousness, tension, apprehension, derealization, and depersonalization. Anticipatory anxiety is accompanied by both hyperventilation and HPA activation (Abelson et al., 2010).

It thus appears that both excessive and inadequate ventilation can stimulate HPA axis activation, that there are both afferent and efferent pathways connecting the hypothalamus to respiratory control and monitoring centers in the brain, this may support the effect of meditation in this study.

Given the intuitive connection between respiratory distress and fear, anxiety or the flight response, and the critical need for oxygen in stress adaptation, it is not surprising that the respiratory-anxiety link is of scientific interest (Wilhelm et al., 2006).

Though the psychophysiology of respiration and the neuroendocrinology of stress are both vibrant areas of research, there is little work done examining their intersections. However, given growing evidence linking neurobiological regions regulating emotional control with both respiratory phenomena and stress hormones (Jankord and Herman, 2008), and growing evidence that both systems are dysregulated in anxiety-related psychiatric disorders (Abelson et al., 2007; Wilhelm et al., 2006; Young et al., 1998), further study of intersections may now be worthwhile.

In a study there was a negative association between low cortisol concentrations and symptoms of anxiety, depression, or conduct disorder (Dorn, 1993; Susman et al., 1999). Individuals with high HPA axis reactivity tend to have more significant distress (anxiety, depression, etc.) symptoms, and higher cortisol concentrations (Van et al., 1996). However, the association between high cortisol concentrations and distress has come mainly from studies of more severely or chronically distressed subjects (Rahe, 1990; Grossi et al., 2001).
Much of the work in this area has found that high basal and reactive cortisol characterizes socially anxious peoples. For example, temperamentally shy and inhibited preschoolers, seven-year-olds (Schmidt et al., 1999), and young (Windel, 1994) and older adults (Bell et al., 1993) are known to have high basal and/or reactive cortisol responses.

Cognitive deficits and increased activity of the hypothalamus-pituitary-adrenal axis leading to elevated cortisol are hallmarks of depression. Cortisol binds to mineralocorticoid receptors (MR) and glucocorticoid receptors (GR). These receptors show their highest density in the hippocampal area, which is closely related to cognitive function, especially verbal and visuospatial memory. Results suggested that cognitive deficits appear to be related to cortisol secretion in depressed patients. Since hippocampus and prefrontal associated cognitive domains showed the strongest correlations with elevated cortisol in patients, these areas seem to be most vulnerable to chronically elevated glucocorticoids. Hypothalamus-pituitary-adrenal activity might be a promising target to treat cognitive dysfunction in major depression (Kim, et al., 2009).

Socially phobic adolescent females have been shown to exhibit increases in cortisol in anticipation of a socially stressful task (Martel et al., 1999). Still others have found increased cortisol reactivity in response to social and/or anticipatory stress (Kirschbaum and Hellhammer, 1994). However, the relation between socially anxious peoples and high cortisol is not a foregone conclusion (Kirschbaum et al., 1994). For example, some researchers have reported no differences in baseline cortisol between socially phobic adults and their same age- and sex-matched controls, but rather a hyper-reactive cortisol release in response to a social stressor. And still others have found lower cortisol reactivity in people with social phobia than in controls.
during a psychological stress test, despite the fact that the test produced subjective reports of anxiety (Furlan, 1993).

In contrast, neural and behavioral evidence from animal models suggests that although high levels of glucocorticoids impair information processing, mild elevations enhance memory (de Kloet et al. 1980). Thus, previous studies suggest that physiologic responses that encourage participation in sports may also influence the ability to perform the task optimally. The exact nature of this relationship remains equivocal and warrants further investigation (Gerhard et al., 2000).

(Mark et al., 2009) used Salmetrics kit to measure Cortisol measurement.

(Oliver T., 2001) supports increased cortisol and impaired cognition/attention in elderly population. Since the HPA axis is activated by stress, it is conceivable that the stress that accompanies disease could lead to both altered cortisol levels and cognitive impairment.

When facing a social stressor of certain intensity, the subjects exhibiting higher neuroendocrine activations (salivary cortisol concentrations) are also characterized by larger shifts of cardiac sympathovagal balance towards sympathetic dominance; there is a clear consistency in the individual responsively to the two stress interviews, at the physiological and behavioral level, as well as at the level of psychophysiological perception. In other words, the parameters used in this study could be considered as trait characteristics, i.e. individual strategies of coping with a stressor that are substantially stable within each individual (Sgoifo et al., 2003).

Emerging themes suggest that the HPA axis and its end product cortisol play a major role in shaping biobehavioral capacities to adapt to changing and challenging environments, both through early programming of developing organ systems and through ongoing influences on
acute and chronic responses to threats to survival; that a healthy and appropriately responsive respiratory system is equally critical to survival.

### 2.6.2 Circadian and Gender Differences

Cortisol concentrations vary according to a well-documented circadian rhythm, highest between 6 a.m. and 8 a.m. (depending on awakening time, Kudielka and Kirschbaum, 2003) and declining throughout the day, reaching lowest concentrations around midnight.

Increasingly, however, HPA-axis researchers are focusing on the marked diurnal rhythm in the release of cortisol, with various elements of this rhythm viewed as essential indicators of HPA axis functioning. The diurnal cortisol rhythm is typically characterised by high levels upon waking, a substantial (50—60%) increase in cortisol concentration in the 30—45 min after waking (called the cortisol awakening response or CAR), and a subsequent decline over the remainder of the day, reaching a low point or nadir around midnight (Kirschbaum and Hellhammer, 1989). Healthy HPA-axis function is thought to require the presence of strong diurnal patterning, and deviations from the typical diurnal cycle of cortisol provide valuable information regarding environmental influences on the HPA axis and the role of the HPA axis in disease processes (Stone et al., 2001). The exact interpretation of each of the elements of diurnal HPA axis functioning is still subject to debate, but recent reviews are beginning to close in on the meaning and relevance of the different aspects of the rhythm (Chida and Steptoe, 2009). The size of the CAR, for example, has been correlated with a variety of psychosocial processes and health outcomes (Adam et al., 2006). Both the absence of a CAR, or an atypically large CAR have been found in past research to associated with negative health outcomes. Flattening of the diurnal cortisol slope, indicated by a slower rate of decline in cortisol across the day, has been related to both chronic and acute psychosocial stress (Adam et al., 2006). There is therefore increasing
accord among investigators that diurnal changes in cortisol are important, and that the CAR and diurnal slope are key elements of diurnal cortisol activity to measure, whether in smaller scale projects or in the type of large-scale epidemiological research.

(Jana et al., 2010), Organisms not only regulate their physiological functioning in response to acute environmental demands, but also rely on biological rhythms to continuously adapt to the environment. Thus disruption of biological rhythms can impair the health and well being in humans, disturbed rhythmicity has been associated with a variety of mental and physical disorders. The suprachiasmatic nucleus (SCN) in the hypothalamus is discussed as the main circadian pacemaker, integrating endogenous and exogenous information. Almost every physiological system has some degree of circadian rhythm that can be influenced not only by light exposure and the typical sleep-wake cycle but also by factors like age, sex, and stress. Autonomic nervous system (ANS) is one of the main stress-sensitive systems in humans, and shows a distinct circadian rhythm, with sympathetic activity increasing significantly during the day and decreasing during night, while parasympathetic activity decreases during the day and increases during night. Chronic stress effects on autonomic functions showed an increase of sympathetic activity and a concomitant decrease of parasympathetic function.

(Kudielka et al., 2003), Acute subjective-psychological stress responses, acute subjective psychological stress responses occur within seconds and may change dynamically during a prolonged stress situation, cortisol responses reach their peak approximately 15—20 min after the onset of the stressor and change less dynamically. In chronic stress, it can be assumed that situational or psychological factors initially mask an existing impact of exhaustion since an effect of exhaustion became only apparent after repeated stress exposures. In case of early morning sessions, an experimenter should ensure that the onset of a stress experiment does not
interfere with the cortisol awakening response (CAR). Secondly, we observed that absolute salivary cortisol response curves after acute psychosocial stress exposure are much higher in the morning although comparable net free cortisol increases can be assessed with equal reliability in the morning and afternoon.

2.6.3 Role of Male and Female in Cortisol Measurement

In this study repressors and high anxious participants demonstrated higher basal salivary cortisol levels than low anxious participants. Women had significantly higher cortisol levels than men during the morning (8:00AM) assessments. Other studies found that salivary cortisol values declined with age among women, but not men. This is the reason our study included only men. Most importantly, the overall pattern of differences among the coping style groups was the same for men and women. Although the relation between the HPA axis and immune system is extremely complex, cortisol is often immunosuppressive (Kim et al., 2009).

Salivary cortisol increases in men are up to twice as high as in women. The typical mean response magnitude in men ranges from 200 to 400% increase from baseline whereas in women 50—150% changes are usually found. Moreover, in men the sole anticipation of an upcoming psychosocial stress task led to a significant saliva cortisol response even when they were not actually confronted with the stressor. A similar anticipatory endocrine response was absent in women (Kirschbaum et al., 2007).

In respect to the female menstrual cycle phase earlier studies only reported on plasma cortisol responses (Tersman et al., 1991). Women in the luteal phase had saliva cortisol stress responses comparable to those of men whereas women in the follicular phase or women taking oral contraceptives showed significantly lower salivary cortisol responses. Such results underline
the importance of strictly distinguishing between the total cortisol secretion and the levels of bioavailable free cortisol, as can be measured in saliva raised the idea of a possibly modulating role of corticosteroid binding globulin since steroid binding globulin levels in the blood (including CBG) are significantly altered by intake of oral contraceptives containing the synthetic estradiol component ethinyl estradiol (Wiegratz et al., 2003). Early life experiences: pre and postnatal stress, Salivary and plasma cortisol responses to pharmacological stimulation have also been shown to be significantly associated with birth weight and gestational age (Ward et al., 2004). The reason why females are not included in this study.

It is known that the social environment can exert modulating effects on salivary cortisol stress responses. In men, brief social support resulted in significantly decreased salivary cortisol responses depending on the quality of support whereas women showed even marginally higher salivary cortisol responses when supported by their own partner in life (Kirschbaum et al., 1995).

According to some investigators, the rhythm of plasma cortisol can be considered to be a stable marker of the circadian cycle because of its reproducibility over time both in separate individuals and in groups. On the other hand, because the major component of plasma cortisol is linked to carrier proteins, plasma cortisol may not reflect the fluctuations of free cortisol, which is actually responsible for the biological actions of the hormone. Thus, the determination of free cortisol in saliva may be a more reliable marker of the real functional status of the HPA axis (Yaneva M.et al., 2004).

2.6.4 Relaxation Therapies on Cortisol

Besides the social environment psychological interventions like brief group-based cognitive-behavioral stress management or relaxing music potentially reduce salivary cortisol
stress responses to an acute stress exposure and such effects may persist over time in both men and women (Khalfa et al., 2003; Hammerfald et al., 2006).

Interventions like cognitive behavioural therapy, mindfulness-based stress reduction and transcendental meditation have all been shown to relieve some of the negative psychological consequences of stress and correspondingly lower levels of the hormone cortisol. The impact of a range of different stress management approaches on cortisol levels have usually employed longer periods of training. For example in a partly comparable study basal urinary cortisol levels were shown to be lower in students who had practiced transcendental meditation (TM) for an average of 8.5 years, compared to non-practicing classmates (Walton et al., 1995).

Relevant to the finding reported here the cortisol levels correlated negatively with number of months of practice; clearly the current study explored the impact of a much shorter period of practice, which may explain why the effects were not generalized to the non-group practice day. Similarly TM training for four months in healthy volunteers reduced average basal cortisol levels compared to a control group and guided imagery and music therapy also lowered levels of cortisol in healthy volunteers after 13 weeks of training (McKinney et al., 1997).

(Michael et al., 2004), there was a significant difference between the salivary cortisol responses immediately following the high and low intensity exercise protocols. Immediately following the high intensity acute resistance exercise bout there was a significant elevation of 97% in salivary cortisol from baseline. This increase in salivary cortisol was significantly larger than the cortisol response for the low intensity resistance exercise session. It has been demonstrated that salivary measures of cortisol can be used to delineate between high and low
intensity workouts. This scale would be a beneficial tool for researchers, strength coaches, recreational weightlifters, and athletes as they strive to rate the work intensity of a resistance training session. Thus these relaxation therapies can decrease the cortisol levels after these type exercises and can optimise sports performance.

Only four published studies that used salivary cortisol as a dependent variable have been done in the field of neuroimmune modulation, and these have yielded inconsistent results. In two studies, different relaxation techniques such as Benson's relaxation response (Benson, 1975), guided visualization, back massage, lying quietly with eyes closed, and viewing a humorous film either did not affect or actually increased salivary cortisol levels (Green and Green, 1987; Hubert et al., 1993). In the remaining two studies, however, it was shown that practicing Tai Chi reliably reduced levels of salivary cortisol (Jin, 1989, 1992). The induced state of relaxation would significantly reduce levels of salivary cortisol, while an equal amount of quiet sitting would not have a significant effect on salivary cortisol in control subjects: salivary cortisol levels for subjects differed as predicted (Laura et al., 2002).

Primary insomnia is associated with a disturbance of cortisol secretion, whereby an increase in 24-h urinary cortisol levels has been shown (Vgontzas et al., 2001) this is supporting the improved sleep quality by meditation decreases the s cortisol level.

2.6.5 Plasma Vs Salivary Cortisol

Cortisol (hydrocortisone, compound F) is the major glucocorticoid produced in the adrenal cortex. Cortisol is actively involved in the regulation of calcium absorption, blood pressure maintenance, anti-inflammatory function, gluconeogenesis, gastric acid and pepsin secretion and immune function. As determination of free cortisol level in serum is not carried out
routinely due to methodical reasons, alternative methods for adrenal function assessment were sought. One such possibility is to calculate the free cortisol index; a second is to determine salivary cortisol.

Until recently there were difficulties in assessing the effects of stress on levels of cortisol in the blood, since taking a blood sample in itself induced stress in the subject, which confounds the experimentally induced stress. In recent years, however, salivary cortisol has been shown to reliably reflect levels of unbound cortisol in the blood and raised levels have been found to be associated with stress in normal subjects (Kirschbaum and Hellhammer, 1994).

According to Kirschbaum and Hellhammer (1994), measurement of cortisol in saliva has become a valuable alternative due to the non-invasiveness and laboratory independence of sampling. Cortisol levels in saliva are not affected by saliva flow rate since the hormone probably enters saliva by passive diffusion. In addition, the acinar cells lining the saliva glands prevent proteins and protein-bound molecules from entering saliva. Thus, salivary cortisol determination is a simple measure of the unbound “free” hormone fraction and has a number of potential advantages over the more conventionally used total serum concentrations. These advantages include a stress-free and non-invasive collection procedure and the measurement of a parameter which is believed to reflect the serum concentration of biologically active unbound cortisol.

According to (Lac, 1993), Saliva has been revealed as a convenient and useful alternative medium to plasma for steroid screening, since the very same conclusions may be drawn from plasma and saliva levels of cortisol, androstenedione, DHA, and DHAS.
With the older children and adults saliva samples can be obtained without assistance. This could enable samples to be collected at home however samples have most often been collected in laboratory settings so that they could be frozen immediately. The concern with mailing samples unfrozen would be that the concentration of cortisol in samples might be alerted by conditions encountered before arrival at the laboratory, such as temperature, motion, and growth of organisms. Result of this study showed that cortisol concentrations are stable during extended periods without freezing when exposed to widely varying temperatures and movement (Kim et al., 2009).

Cortisol remains stable in saliva for several days and so is suited to investigations in which the participant is required to provide multiple samples away from the study site (Kahn et al., 1988).

2.6.6 Enzyme Immune Assay (EIA) Vs Radio Immuno Assay (RIA)

The analytical technique most used to determine cortisol levels was traditionally radioimmunoassay. (MSL Lo et al., 1992), Time matched samples of 2-3 ml saliva were collected by direct salivation in to wide mouth vessel and stored at -20degree centigrade until analysis. In this study there by indicating that salivary cortisol measurements is a better index for adrenal status, by the clinical application of salivary cortisol measurements were evaluated by radioimmunoassay of saliva and plasma samples. Salivary cortisol levels of normal subjects exhibited a significant (p 0.001) diurnal variation with concentration of 8.7 ± 4.8nmol at 0800-1000h and 2.4 ± 1.1nmol/L at 1500-1700h (Figure.2.6).

Nowadays, the use of other nonradioactive markers is becoming increasingly popular. This avoids the complications of using radioisotopes especially those relating to public health risks and infrastructure required for the distribution, use and elimination of radioactive
substances. This work involves the development and validation of an enzyme immune assay technique (EIA) for measurement of the cortisol concentration in cattle saliva. Saliva components do not affect EIA as plasma components do. Commercially available radioimmunoassay kits for human plasma (detection range 10-100 ng/ml) are not sensitive enough for animals with low concentrations of salivary cortisol (4 ng/ml). Thus EIA is the method of choice cattle (Chacon et al., 2004).

Sensitivity, specificity, precision and accuracy EIA tests showed this method to be suitable and reliable. The detection limit was found to be 0.024 ng/ml representing an improvement on previously described techniques. Intra-assay and inter-assay variation coefficients were 1.47-7.30% and 2.40-9.78%, respectively. The recovery rates for cortisol added to saliva samples were 91.36-126.5%. Parallelism tests showed that saliva cortisol levels can be determined in cattle samples without extraction. The correlation between saliva and plasma cortisol was positive (r=0.75) and saliva/plasma cortisol ratio was around 10%. Therefore, saliva samples are a suitable alternative to plasma samples in HPA (hypothalamic-pituitary-adrenal) axis evaluation (Chacon et al., 2004) (Figure 2.7).

2.6.7 HPA-Axes Physiology

The HPA axis serves as an important pathway by which social and psychological factors influence biology and health. Stressful stimuli serve to activate HPA function to cause an increase in peripheral cortisol. Cortisol can effect physiological changes that encompass most of the main organ systems, helping to provide the energetic resources needed to face the stressor at hand, and also helping to modulate and contain other components of the physiological stress response (Sapolsky et al., 2000). Although short-term activations of the HPA axis are adaptive and necessary for everyday functioning, extreme, frequent or chronic activation of this system are associated with negative health outcomes. Existing research has implicated the HPA axis in...
the development of a variety of sub-clinical and clinical conditions including metabolic syndrome (Brunner et al., 2002), depression (Belmaker and Agam, 2008), risk for cardiovascular disease (Smith et al., 2005) and cognitive decline (Seeman et al., 1997). Many early large-scale studies of cortisol and health focused on “average” cortisol measures, particularly urinary measures of cortisol, in part because such methods provided levels that are pooled across multiple hours, and total exposure to cortisol across 12 or 24 h was the measure of interest (Seeman et al., 1997).
A. With sufficient input, neurons in the paraventricular nucleus (PVN) of the hypothalamus release corticotrophin releasing hormone (CRH) into the portal system connecting the anterior pituitary (B.), causing adrenal corticotrophin hormone (ACTH) to be released into the general circulation. C. Adrenal cortical cells respond to ACTH by producing and releasing the steroid cortisol, which is distributed throughout the body via the general circulation. D. One of cortisol’s many functions is to provide negative feedback through receptors located in the hypothalamus and pituitary, thus keeping HPA axis activity in check. (Kalman and Grahn, 2004)
Chemical Structure of Cortisol (Clemens Kirschbaum)

Figure 2.7a: Standard curve for cortisol determination by EIA (Chacón et al., 2004)

(OD: Optical Density)
Although the basic neurochemistry of the stress response is now well understood, much remains to be discovered about how the components of this system interact with one another, in the brain and throughout in the body. In response to a stressor, neurons with cell bodies in the paraventricular nuclei (PVN) of the hypothalamus secrete corticotropin-releasing hormone (CRH) and arginine-vasopressin (AVP) into the hypophyseal portal system. The locus ceruleus and other noradrenergic cell groups of the adrenal medulla and pons, collectively known as the LC/NE system, also become active and use brain epinephrine to execute autonomic and neuroendocrine responses, serving as a global alarm system. (Figure 2.6)

The autonomic nervous system provides the rapid response to stress commonly known as the fight-or-flight response, engaging the sympathetic nervous system and withdrawing the parasympathetic nervous system, thereby enacting cardiovascular, respiratory, gastrointestinal, renal, and endocrine changes. The hypothalamic-pituitary-adrenal axis (HPA), a major part of the neuroendocrine system involving the interactions of the hypothalamus, the pituitary gland, and the adrenal glands, is also activated by release of CRH and AVP.

This results in release of adrenocorticotropic hormone (ACTH) from the pituitary into the general bloodstream, which results in secretion of cortisol and other glucocorticoids from the adrenal cortex. The related compound, cortisone, is frequently used as a key anti-inflammatory component in drugs that treat skin rashes and in nasal sprays that treat asthma and sinusitis. Recently, scientists realized that the brain also uses cortisol to suppress the immune system and reduce inflammation within the body. These corticoids involve the whole body in the organism's response to stress and ultimately contribute to the termination of the response via inhibitory feedback.
Kellendonk et al., (2002) established that both high and low levels of stress and Cortisol secretion affect hippocampal function opposite to that of the ideal intermediate levels. This may suggest a neurochemical basis for the inverted-U hypothesis. Future studies involving the neural mechanism underlying anxiety may solidify the effect of anxiety on athletic performance.

Stress which is often subjectively characterized by anticipation of future calamity in the absence of an ability to control, shape or cope with the anticipated negative outcome. This is the quintessential type of situation that activates our central, neuroendocrine stress response system, the hypothalamic-pituitary adrenal (HPA) axis, leading to release of cortisol from the adrenal cortex (Dickerson and Kemeny, 2004).

2.6.7.1 Structure and Function of the Neuroendocrine Axis

The main goal of the stress system is to react to subtle changes in the environment to efficiently maintain the body in a homeostatic state. The two main neuroendocrine axes activated in response to stress, sympathetic adreno-medullary (SAM) and HPA, have been related to "different and relatively independent dimensions of the hormonal activation in the coping to stress" (Weiner, 1992). The SAM, activated during the "effortful" coping with a stressor, implies increases in the HR and in the BP, together with the liberation of adrenaline and noradrenaline. The activation of HPA is associated with the inability to cope, distress and despair, and the perceived uncontrollability to cope is associated with the liberation of ACTH and cortisol. With a high positive loading in epinephrine and low positive loadings in norepinephrine and cortisol excretion. These two factors were confirmed in other studies employing strong, acute stressors, such as parachute jumping and a swimming test for non-swimmer recruits (Ellertsen et al., 1978; Vaernes et al., 1982).
Stimulation of the hypothalamic-pituitary-adrenal (HPA) axis is precipitated by release of adrenocorticotrophic hormone (ACTH) from the anterior pituitary. In response to stress, this results from synergistic stimulation of the pituitary by corticotrophin-releasing hormone (CRH) and arginine vasopressin (AVP) from neurons originating from parvo- and magnocellular neurons in the peraventricular nucleus of the hypothalamus (PVN). CRH and AVP reach the pituitary through a circumscribed portal circulation where they trigger the release of adrenocorticotropin (ACTH) into general circulation. CRH provides the primary pathway for central control of ACTH release, but AVP plays an important role and can take over and help sustain acute reactivity under conditions of chronic stress.

The role of Cortisol in the hypothalamic-pituitary-adrenal (HPA) axis is of particular importance in understanding and measuring precompetition anxiety. (Fisher, 1989) described the HPA stress pathway as follows: at the onset of a perceived threatening stimulus, the corticotropin releasing hormone (CRH) is activated in the hypothalamus and travels to the anterior pituitary. Then, ACTH is initiated and migrates to the cortex of the adrenal glands. At that point, glucocorticoids such as Cortisol are released. One role of Cortisol is to go into a feedback loop and inhibit the HPA axis. Another function of Cortisol, however, is to migrate to various parts of the body including the cognition-relevant hippocampus (Fisher, 1989). Since cognition is involved in athletic performance, an understanding of how precompetition anxiety affects Cortisol may have implications for sport psychology researchers.

ACTH has a relatively short half-life, acting quickly and briefly to stimulate the adrenal cortex (zona fasciculate) to release the glucocorticoid cortisol. It acutely stimulates cortisol production and secretion. With repeated bursts of ACTH release, it also stimulates the synthesis of cortisol producing enzymes and co-factors. Only 5-10% of circulating cortisol is free and
active; the rest is bound to binding proteins (cortisol-binding globulin (CBG) and albumin). CBG levels vary across individuals and are affected by sex and gonadal hormones, possibly playing a regulatory role in glucocorticoid action (Kumsta et al., 2007). There are two types of cortisol receptors: Type I, mineralocorticoid (MR) and Type II, glucocorticoid (GR). Both are located in cell cytoplasm, where cortisol enters passively. After binding, the cortisol-receptor complex moves into the cell nucleus and binds to glucocorticoid receptor elements (GRE) on DNA sites, thereby inhibiting or promoting transcription of regulatory proteins. The density, binding affinity and regional distribution of GR and MR differ and play a role in cortisol effects, particularly at higher concentrations, when MR becomes saturated and occupancy and activation of GR rises. In addition to cytoplasmic, genomic effects, glucocorticoids also exert quick, non-genomic effects on cell signaling processes that shape homeostatic regulation more rapidly (Herman et al., 2003). This system is highly regulated in a very complex way, attesting to the considerable importance of its impact on effective adaptation and survival.

Primary physiological effects of glucocorticoids include energy mobilization (increasing glucose levels), suppression of immune responses, anti-inflammatory effects, growth inhibition, and inhibition of reproductive function. It directly stimulates glucose synthesis, stimulates other gluconeogenesis-mediating hormones (e.g. glucagon), and inhibits glucose uptake into cells by promoting insulin resistance.

The chief components of the "stress axis" (the hypothalamic-pituitary-adrenal or HPA axis) are the paraventricular nucleus of the hypothalamus (PVN), the anterior portion of the pituitary, and the cortex of the adrenal glands. Cells in the PVN release corticotrophin releasing hormone (CRH) in response to circadian drive, a variety of pharmacological agents, trauma, or psychosocial perturbations. CRH, traveling in a portal vascular system, binds to corticotrophs in
the anterior pituitary causing the synthesis/release of adrenal corticotrophin hormone (ACTH) into the general circulation. In turn, circulating ACTH binds to receptors on adrenocortical cells resulting in the synthesis/release of cortisol into the bloodstream (reviewed by Miller and O'Callaghan, 2002). The typical circadian pattern of cortisol secretion shows an increase in the early morning hours that peaks at or slightly before the time of waking. However, depending on the strength of the stimulus (e.g., stressor), cortisol levels in the afternoon and evening can be elevated above those of the circadian peak. Cortisol exerts its effects throughout the brain and periphery primarily through binding to two known types of corticosteroid receptors—the glucocorticoid receptor and the mineralocorticoid receptor (Brian and Ruth, 2004).

The HPA axis serves as an important pathway by which social and psychological factors influence biology and health. Stressful stimuli serve to activate HPA function to cause an increase in peripheral cortisol. Cortisol can effect physiological changes that encompass most of the main organ systems, helping to provide the energetic resources needed to face the stressor at hand, and also helping to modulate and contain other components of the physiological stress response. Although short term activations of the HPA axis are adaptive and necessary for everyday functioning, extreme, frequent or chronic activations of this system are associated with negative health outcomes.

Psychological stressors are central stimuli that require processing at higher brain levels. In the pharmacological testing of HPA axis regulation, reported outcome variables are typically ACTH and total plasma cortisol levels. Salivary cortisol concentrations are less frequently measured although the amount of salivary cortisol predominantly reflects the free, biologically active fraction of cortisol. Salivary cortisol agrees very well with the amount of free cortisol in
blood but does not necessarily show high correlations with total cortisol levels (Vining et al., 1983; Kirschbaum and Hellhammer, 1989, 1994, 2007).

2.6.8 Salimetrics™ Cortisol Kit

The Salimetrics™ cortisol kit is a competitive immunoassay specifically designed and validated for the quantitative measurement of salivary cortisol. It is not intended for diagnostic use. It is intended only for research use in humans and some animals. Historically, the immunodiagnostic community's approach to the application of immunoassay techniques in the measurement of biomarkers in saliva has been problematic. This assay kit was designed to address those problems. To ensure the most accurate results, this salivary immunoassay uses a matrix that matches saliva. Second, the level of cortisol in saliva is significantly lower than levels in the general circulation. The use of a standard curve developed to capture the range of values expected in serum/plasma samples is often not sensitive enough to capture the complete range of individual differences in the level expected in saliva. This assay was designed to capture the full range of salivary cortisol levels (0.003 to 3.0μg/dL) while using only 25 uL of saliva per test.
Table 2.3: Salivary Cortisol Expected Ranges (Aardal, E., 1995)

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>AM Range (µg/dL)</th>
<th>PM Range (µg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children, ages 2.5-5.5</td>
<td>112</td>
<td>0.034 - 0.645</td>
<td>0.053 - 0.607</td>
</tr>
<tr>
<td>Children, ages 8-11</td>
<td>285</td>
<td>0.084 - 0.839</td>
<td>ND - 0.215</td>
</tr>
<tr>
<td>Adolescents, ages 12-18</td>
<td>403</td>
<td>0.021 - 0.883</td>
<td>ND - 0.259</td>
</tr>
<tr>
<td>Adult males, ages 21-30</td>
<td>26</td>
<td>0.112 - 0.743</td>
<td>ND - 0.308</td>
</tr>
<tr>
<td>Adult females, ages 21-30</td>
<td>20</td>
<td>0.272 - 1.348</td>
<td>ND - 0.359</td>
</tr>
<tr>
<td>Adult males, ages 31-50</td>
<td>67</td>
<td>0.122 - 1.551</td>
<td>ND - 0.359</td>
</tr>
<tr>
<td>Adult females, ages 31-50</td>
<td>31</td>
<td>0.094 - 1.515</td>
<td>ND - 0.181</td>
</tr>
<tr>
<td>Adult males, ages 51-70</td>
<td>28</td>
<td>0.112 - 0.812</td>
<td>ND - 0.228</td>
</tr>
<tr>
<td>Adult females, ages 51-70</td>
<td>23</td>
<td>0.149 - 0.739</td>
<td>0.022 - 0.254</td>
</tr>
<tr>
<td>All adults</td>
<td>192</td>
<td>0.094 - 1.551</td>
<td>ND - 0.359</td>
</tr>
</tbody>
</table>

Third, the pH of saliva is easily lowered or raised by the consumption of food or drink. Performance of immunoassays becomes compromised as the pH of samples to be tested drops below 4. This results in artificially inflated levels. This assay system is designed to be resilient to the effects of interference caused by collection techniques that affect pH. In addition, a built-in pH indicator warns the user of acidic or basic samples (Table.2.3).

Salivary Cortisol, Saliva samples present several advantages over plasma samples in animal welfare studies. Saliva collection avoids venipuncture as a stress factor. Also, saliva components do not affect EIA as plasma components do.

2.7 Heart Rate Variability

In the last two decades, analysis of HRV has been extensively applied to the investigation of normal physiology. Prior to the HRV era, investigation of autonomic physiology required the
use of complex sympathetic activity occurring in association with highly invasive techniques in animal models or imprecise reflex based tests in humans. The use of HRV analysis has provided a simple reproducible method of non-invasive autonomic assessment. This has helped to clarify the role of the autonomic nervous system in regulating the cardiovascular response to changes in posture (parasympathetic dominance when supine, sympathetic dominance when standing), stress (sympathetic dominance) and exertion (sympathetic dominance). The purpose of this review is to discuss physiological and technical aspects of HRV analysis, along with an overview of the research and clinical applications of the techniques.

Physiologic systems generate complex fluctuations in their output signals reflecting the underlying dynamics. In the human body, both the autonomic nervous system (ANS) and the humoral system have direct effect on heart rate coordination. Heart rate variability (HRV), as the conventionally accepted term to describe variations of both instantaneous heart rate and RR intervals, has aroused more and more interest since its recognition.

Parameters derived from HRV have been proved to be useful in prognosis and diagnosis of heart diseases. Finding and analyzing hidden dynamical structures of these signals are of basic and clinical interest. Most recently, the applications of HRV have been also extended to sports field. HRV analyses for the athletes have been attempted to monitor sports training. Most of such studies are focused on evaluating modifications of cardiovascular system regulated by the ANS resulting from physical exercise, exploring HRV indicators of fatigue induced by over reaching and overtraining for endurance athletes, as well as quantifying alterations of HRV measures related to workloads and training intensity during different exercise periods.

The cardiovascular system displays features typical of self-organizing systems designed to achieve dynamical stability. In the case of the cardiovascular system, stability is achieved by autonomically mediated control of heart rate, blood pressure and other factors which react
rapidly to a range of internal and external stimuli such as acute ischaemia, metabolic imbalance and changes in physical or mental activity. In particular, heart rate varies in a complex reactive manner to these stimuli (which occur even in resting individuals).

The less frequently used physiological measure of heart rate was positively correlated with both somatic and cognitive anxiety intensity. Correlations with percent change scores indicated that as an individual's heart rate increased from baseline to pre-competition, self-confidence decreased and both somatic and cognitive anxiety increased. Heart rate is often surpassed for the seemingly more accurate measure of Cortisol, but perhaps its demonstrated relationship with anxiety constructs indicates that it can be used as a gross barometer of pre-competition anxiety.

2.7.1 Role of Cardiac Cycle in Shooters

In (Helin et al., 1987) the elite pistol and rifle shooters triggered consistently late in the cardiac cycles, i.e. during the diastolic phase, whereas the novice shooters triggered randomly during the cardiac cycle. It was also found that the beginning shooters achieved better shooting scores when they triggered during diastole, that is, during the resting phase of the heart. The view that the best time to pull the trigger should be in the diastolic phase of the cardiac cycle was lent support by (Bothwell et al., 1997). In their study on experienced rifle shooters, mean scores triggered in diastole were significantly better than those triggered in diastole.

Anticipatory cardiac deceleration has been observed to develop several seconds immediately before an expected event requiring attentional processing. Common interpretations of this phenomenon derive from studies by (Lacey and Lacey, 1980). In a reaction time (RT) paradigm involving a fixed fore period between the ready signal and imperative signal, a systematic heart rate (HR) deceleration beginning three to four beats before the imperative
stimulus was noted. This deceleration was not related to respiration since it occurred with a wide variety of accompanying respiratory patterns.

In another early study Stern, (1976) examined anticipatory HR between the 'Get Set'-5 s delay-'Go' commands, and found that subjects, preparing for either a spring up a flight of stairs or a bicycle sprint, showed a phasic HR change of acceleration until 1 s before the 'Go' signal, and a deceleration from 1 s to the 'Go' command. Prior to four different movement responses, a similar deceleration occurred, although cardiac acceleration subsequent to the response differed with the extent of muscle involvement in the response.

Obrist, (1981) emphasized the decrease in motor activity that accompanies HR deceleration. The HR change was not a direct correlate of attention, but an indirect effect caused by a quietening of motor activity.

It is commonly suggested in the sport psychology literature that peak performance occurs at optimal levels of arousal (Taylor, 1987). It is generally assumed in this context that arousal levels should be lowered in competitive situations for optimal performance (Hardy et al., 1996). An early lower arousal level, 15-20 s before initiation of the shot, may facilitate the development of attention focusing. The cardiac data present a picture of experts developing a marked state of attention focusing or vigilance in the 10-15 s prior to their initiation of the shot. If this is enhanced and continues to develop to the moment of the shot, better performance occurs.

Stimulus intake is associated with cardiac deactivation or deceleration, while stimulus rejection is accompanied by cardiac activation or acceleration. (Lacey and Lacey, 1974, 1980) it shows the importance of decrease HR prior to competition for the better performance.

Other theorists have differing perspectives regarding the role of HR deceleration in attentional situations. (Brunia, 1984) investigated the cardiac and somatic responses during his
research on response preparation effects in a comparison of the differing hypotheses of (Lacey and Lacey, 1980; Obrist 1981). His results were consistent with the Laceys' perspective in that HR deceleration occurred before a participant's response, but this cardiac activity was not paralleled by general reductions in somatic activity. Brunia pointed out that different parts of the motor system behaved differently in a RT fore period, and that a decrease in activity was generally restricted to small muscles, particularly in the facial region. The general increase in activity of the larger muscles of the trunk and extremities, although small, made it difficult for him to support the cardiac-somatic coupling hypothesis.

2.7.2 Attention in shooting

It appears reasonable to claim that both attentional processing and motor preparation are involved in skilled performance such as that involved in pistol shooting. Visual sustained attention was characterized by a sustained lower mean HR, lowered HR variability and lack of distractibility from the main stimulus (a Sesame Street program) in the presence of a peripheral stimulus (computer-generated patterns). Results indicated that HR deceleration occurred if the infant focused attention, and that when attentional focus switched there was an increase of HR back to normal. It was suggested that the increased duration of HR deceleration while attending, and the slower recovery of HR when attention was broken, which occurred in some infants, was related to greater engagement with the attentional task (Pasty et al., 2001).

A number of studies have examined cardiac activity and attention in the few seconds prior to a sport performance, with mixed results. (Hatfield et al., 1987) found HR acceleration in 17 elite rifle marksmen during the initial stage of aiming (between 5 and 2.5 s prior to the shot) and a non-significant deceleration as the time approached the trigger release (i.e. within 2.5 s prior to the shot). (Salazar et al., 1990), with archery performance, found HR acceleration during
five interbeat intervals (IBIs) 3-4 s preceding arrow release. However, (Konttinen and Lyytinen, 1992), in a study comparing three elite rifle marksmen with three novice marksmen, found that there was a significant HR deceleration during the preparation period in the pre-test, but no significant HR deceleration in the post-test, and no significant differences or interactions in HR between novices and marksmen. It is likely that the physical demands in the (Hatfield et al., 1987) study (i.e. holding a 14-22-kg bow at full draw) over-rode any cognitive effects on HR. In the (Konttinen and Lyytinen, 1992) study, however, the rifle was supported with a chain in order to avoid larger muscular involvement, and this may have allowed a cognitive-related HR deceleration to become apparent, at least in the pre-test.

(Landers et al., 1994) supports this interpretation since a significant cardiac deceleration was found prior to arrow release in beginning archers who were drawing a lighter bow (10-12 kg). Other studies have also reported HR deceleration prior to arrow release or trigger pull (Wang and Landers, 1986; Helin et al., 1987).

Similar data have been reported from golf studies, a sport which shares some of the characteristics of shooting self initiated skilled performance following and dependent upon efficient cognitive/perceptual evaluation of external stimulus complexes (Molander and Backman, 1989).

Among highly skilled golfers (Boutcher and Zinsser, 1990) found a significant HR deceleration of 4-11 beats/min within 3-7 s of the putt. It has been suggested that greater degrees of HR deceleration are associated with better performance (Boutcher and Zinsser, 1990).

It appears, from a consideration of all above literature, that cardiac deceleration may be used as an index of attention when the preparatory state being examined does not involve major physical demands, such as golf putting (Boutcher and Zinsser, 1990) and the sprint start (Stern, 1976). When more physical effort comes into play (e.g. archery and rifle shooting) an HR
deceleration effect is not observed. Thus relaxation trainings would be the right choice for sports like shooting.

It is commonly suggested in the sport psychology literature that peak performance occurs at optimal levels of arousal (Yerkes and Dodson, 1908; Taylor, 1987). It is generally assumed in this context that arousal levels should be lowered in competitive situations for optimal performance (Hardy et al., 1996).

The process of shooting match is a very special physiological state for the athletes, which needs them to concentrate on the target for a long period of time, to keep their psychological activities under control, but expends them less physical energy. Therefore, our focus in this study is on the alteration in scaling behavior of short interbeat interval time series for professional shooting athletes during music therapy and Meditation training, which reflects the underlying control mechanism of the ANS on the heart, beats in such a unique situation.

Rather than sports items in which athletes are expanding more physical strength and demanding endurance, shooting event is technique-oriented and needs athletes more concentration and psychological stability. The athletes are strictly demanded to control their heart beats well when a match is going on, since any bigger fluctuations in their heart beats will lead to shaking of the gun, next a bad shot will come up. Whereas heart beats are regulated by the autonomic nervous system, therefore, professional shooting athletes may have been developing a better autonomic cardiac control due to intensive training and games. A higher value of scaling exponent of heartbeat series under exercise corresponds to a stronger modulating capability of autonomic nervous system. We further examine whether sports capacity or performance of the shooters is related to the alteration in scaling exponents derived from short-term heart rate variability from rest to relaxation training. The result further demonstrates that
elite athletes have the ability to better control their heart beats positively, which contributes to a desirable score in the game.

Perhaps findings have been equivocal due to the broad range of methodological designs. For example, performance measures have been taken in a variety of ways: some researchers opted for the use of subjective measures of performance (Edwards and Hardy, 1996) while others evaluated performance based on statistics (Kais and Raudsepp, 2004; Sonstroem and Bernardo, 1982). Although sport-specific research may be more valuable than multi-sport studies due to the variety of tasks in each sport (Martens et al., 1990).

2.7.3 Stress on Heart Rate Variability

Influence of mental stress on heart rate (HR) and spectral measures of Heart Rate Variability (HRV) has been well documented. It has been reported that various types of mental stresses performed in laboratory conditions increase HR and decrease HRV. The majority of the studies conclude that the reduction in overall variability is induced by the withdrawal of the highly frequent vagal activity (Pagani et al., 1995).

Acute stress may affect cardiac function by shifting autonomic cardiac regulation in favor of the sympathetic nervous system. Environmental conditions that evoke behavioral or physiological responses may be considered stressors. Neurobiological responses are stressor-specific (Pacak and Palkovits, 2001) thus, it is important to study responses to relevant stressors. The most frequently experienced stresses of human beings are social in nature, involving relatively rapid adaptations to the demands of work and the maintenance and nurturing of affiliative relationships. Autonomic responses to social stress are adaptive acutely but may become maladaptive with repeated or chronic social stress. Acute laboratory stressors (e.g., Stroop, Word, Color, Conflict Test) have been observed to increase heart rate (HR), decrease HR variability (HRV), and alter the power spectrum by decreasing the high frequency (HF)
component, increasing the low frequency (LF) component, or increasing the LF/HF ratio consistent with a relative increase in sympathetic modulation (Yin et al., 2004; Kimura et al., 2005; Isowa et al., 2006). Further, naturally occurring psychological stress in ambulatory subjects during a routine day was associated with an increased LF/HF ratio, suggesting relative increases in sympathetic nervous system activity during stressful periods (Sloan et al., 1994a). Finally, self-reported levels of life stress were associated with reduced HRV (Kang et al., 2004). Thus, psychological stress affects HR and HRV.

To explain the different results regarding elevation of SDNN and SDANN, the strongest prognostic HRV markers, differences in exercise time and intensity have been proposed as an explanation (Malfatto et al., 1996).

Decreased HRV has often been reported during physically or emotionally stressful events (Sgoifo et al., 2001). High vagal tone has been linked to efficient autonomic regulatory activity which allows an organism to enhance its sensitivity and response to physiological and environmental challenges (Friedman and Thayer, 1998). Positive emotions may significantly augment the HF component of a power spectrum (McCraty et al., 1995), whereas the opposite occurs with negative emotions. Therefore, cardiac vagal tone may also be an indicator of positive emotional states and recently patterns of HRV reduction have been studied in farm animals in reaction to stressors, behavioural disorders and in the context of cognitive appraisal (Kuwahara et al., 2004).

2.7.4 Heart Rate Variability responses in Experienced Vs Novice shooters

More recently, Konttinen et al., (2003) examined ECG patterns and triggering among beginning rifle shooters, applying a more precise method of investigation of the cardiac cycle than the dichotomous classification applied in the earlier studies. Their results showed that the
participating non-elite shooters fired more often during the phase of 10-50% of the R wave-to-R wave (R-R) interval, and less often during the phase of 50-90%. With regards to the accuracy of performance, the participants exhibited average or above average performance when the shot occurred in the first half (0-50%, including 55% of all shots) or in the end (70-99%, including 27% of all shots) of the R-R interval. They achieved below average shooting results when the shot occurred in the phase of 50-70% (including 18% of all shots).

The findings of Konttinen et al., (2003) appeared then to challenge the view that superior shooting performance could be achieved only by triggering during the relaxation phase of the heart, that is, the end of the R-R interval. The findings have proposed that skilled shooters should achieve better shooting scores if the shot occurs late in the cardiac cycle, that is, during the resting phase of the heart.

Earlier research on heartbeat detection has shown that detectable sensations associated with heartbeat occur mostly between 150 and 350 ms following the R-peak (Ring and Brener, 1996), and most people detect their heartbeats about 200 ms after the R-peak. Based on these studies, there seem to be good grounds to propose that it might be possible for a beginning shooter to detect heartbeat sensations during the aiming, and to take advantage of this information in shooting training.

Our approach was to investigate HRV in response to the pre-competition stress aloud in order to get better insights into its qualitative properties. However, careful analysis showed that spectral measures of HRV could assess influence of mental stress aloud. The influence was reflected on HF spectral power, which either decreased or increased upon mental stress aloud.

In previous research, heart rate variability (HRV) was found to serve as a physiological index of self-regulatory strength (Segerstrom and Solberg, 2007). As the ability to exert self-
control predicts a broad range of positive outcomes, such as academic and interpersonal success (Tangney et al., 2004), it seems reasonable to expect HRV to be associated with subjective well-being (SWB). SWB refers to well-being from the people’s own perspective. It includes both cognitive judgements of satisfaction with life and affective evaluations of pleasant and unpleasant affect.

The assumption that HRV is associated with SWB was indirectly supported by a study showing an inverse relationship between perceived emotional stress and HRV (Dishman et al., 2000).

More specifically, based on the assumption that adaptive self-regulation relies on the capacity to exert control over cognitions, emotions, behavior, and physiology, HRV to be related to cognitive strategies of emotion regulation that involve executive functions, such as reasoning, generating, and following through with goals and plans (Suchy, 2009).

The Neurovisceral Integration Model (Thayer et al., 2009) provides a theoretical rationale for explaining the role of HRV as an index of self-regulatory strength. Within this model, which outlines the associations among different self-regulatory processes, the central autonomic network (CAN) is assumed to adjust physiological arousal to changing situational demands and thus to support goal directed behavior and adaptation. The primary output of the CAN is mediated through sympathetic and parasympathetic (vagus nerve) neurons that innervate the heart. The interplay of these inputs with the cardiac sinoatrial node produces variability in the heart rate (HR) time series. Thus, the output of the CAN is directly linked to HRV, the beat-to-beat variation in heart rate.

(Thayer et al., 2009), propose that the CAN and other functional units within the central nervous system represent a common central functional network that is associated with processes
of response organization and selection and serves to control psycho physiological resources in attention and emotion.

The ability to meet changing environmental demands depends on the functioning of this central functional network. Empirical evidence strongly supports these assumptions, indicating that HRV co-varies with processes that are involved in self-regulation, such as emotion regulation (Appelhans and Luecken, 2006), constructive coping (Fabes and Eisenberg, 1997), and the pursuit of goals (Geisler and Kubiak, 2009). More specifically, previous research has indicated that HRV is associated with behaviors that require executive functioning.

Whereas negative associations were found between waking HRV and frequency and duration of worrying (Brosschot et al., 2007). Further support for the use of HRV as a proxy for regulatory strength comes from neurobiological research indicating a link between HRV regulation and prefrontal cortical activity, which is a key structure for executive functioning (Lane et al., 2009).

Executive function and emotion regulation strategies for emotion regulation can be distinguished along different dimensions, such as the time point targeted by a strategy within the process of emotion regulation (Gross and Thompson, 2007). Another possible way to characterize strategies of emotion regulation is by whether they involve mechanisms that reflect executive functioning (Zelazo and Cunningham, 2007). According to Zelazo and Cunningham, executive function includes higher cognitive processes that are involved in goal-directed problem-solving, such as problem representation, planning, execution, and evaluation.

Executive function encompasses mental set shifting, information updating and monitoring, and inhibition of prepotent responses (Miyake et al., 2000). Strategies of emotion regulation that reflect executive function are, for example, reappraisal or refocusing that imply
mental shifting, and planning that involves information updating and monitoring. By contrast, other strategies of emotion regulation appear to be associated with deficits in executive functioning. For example, depressive rumination, a response to dysphoric mood that is characterized by recurrent thoughts focusing on the causes, symptoms, and implications of one’s depressive mood, was found to be related to attentional inflexibility (Davis and Nolen-Hoeksema, 2000) and inhibitory deficits (Whitmer and Banich, 2007).

In previous researches, cognitive strategies of emotion regulation that involve executive mechanisms, such as positive reappraisal, were found to be associated with higher subjective well-being (Shiota, 2006), whereas rumination that reflects deficits in executive functioning, was found to exacerbate depressive mood (Nolen-Hoeksema et al., 2008). Given that HRV can be expected to be associated with the habitual use of emotion regulation strategies that involve executive processes, we tested the hypothesis that these strategies mediate the association between HRV and subjective well-being.

In a study assessed heart rate using a Polar Electro heart rate monitor during the pretest and posttests. Although heart rate (beats per minute, bpm) is an indicator of physiological arousal (not anxiety), it is generally assumed that in situations with comparable levels of physical exertion heart rate can provide some indication of anxiety (Astrand et al., 2003).

Studies measured heart rate at rest for 5 min via the heart rate monitoring system Polar RS800 (Polar Electro Oy, Kempele, Finland). During measurement, participants supine lying by themselves without any task since parasympathetic influences predominate at rest. Using the Polar Precision Performance™ Software, we preprocessed sequential interbeat intervals for artefacts. A visual screening for artefacts followed. We then used the HRV Analysis program (Niskanen et al., 2004) to perform a frequency-based technique of power spectral analysis (autoregressive modeling technique) to extract high-frequency components, 0.15–0.4 Hz, which
primarily reflect cardiac parasympathetic influence from sequential interbeat intervals and also measured LF, LF/HF and Time domains, The absolute value of power was chosen as unit (ms2). With this procedure, we followed the recommendations of the American Heart Association (Task Force, 1996). In a previous study, in which heart rate was measured the same way, we obtained a considerably high retest-reliability coefficient over about 1 h (r = .70), (Geisler and Kubiak, 2009).

HRV would be related to better subjective well-being, as indicated by better mood and higher satisfaction with life. HRV was positively associated with positive hedonic tone (cheerfulness) and positive tense arousal (calmness), and these effects were completely mediates the influence of HRV on satisfaction with life. In doing so, we followed the recommendation of (Shrout and Bolger, 2002).

2.7.5 Respiration on Heart Rate Variability

HRV can be influenced by other nonpathological conditions such as activity or different patterns of breathing (Bernardi et al., 1989). Despite this evidence that slow breaths can generate slow fluctuations that can be confused with those related to sympathetic activity, respiration is generally not measured in Holter studies of long-term HRV.

Breathing patterns (Konttinen and Lyytinen, 1992) should be investigated in parallel to HR to determine the role of lengthening or shortening R-R interval in the decision making process to pull the trigger. Thirdly, the examination of the shooting performance in the prone position could provide us with additional information how heartbeat influences shooting performance. Given that the prone position is relatively free of gross bodily movements, the influence of the small body jerk caused by the heart contraction could be measured as a function of time using e.g. accelerometers attached to a rifle's barrel.
One of the aims of this experiment was to show the effects of paced breathing at 0.2 Hz, compared to uncontrolled breathing, on time and frequency domain measures of heart rate variability. The results showed a marginally significant trend for paced breathing at 0.2 Hz to increase heart rate variability in the time domain, measured by SDNN, and to shift sympathovagal balance, measured by low frequency/high frequency spectral power, toward greater sympathetic activity. Because of the respiration-related variability (respiratory sinus arrhythmia) of electrocardiogram inter-beat (RR) intervals, the necessity of controlling respiratory frequency during measurements of heart rate variability has been demonstrated (DeMeersman et al., 1995). Several mechanisms have been attributed to this observation, e.g., the respiratory sinus arrhythmia might be amplified due to increased tidal volume (De Meersman et al., 1995).

Tidal volume is also reported to be a modulator of the heart rate variability spectrum by increasing high frequency power (Grossman et al., 2004) and 0.2 Hz paced breathing usually increases tidal volume (Pinna et al., 2006) which is what we observed visually in the actions of the respiratory muscles.

With changing posture, may have systematically increased low frequency power and brought about a higher low frequency/high frequency ratio of heart rate variability spectral power during paced breathing. Such modulation of low frequency power has been shown to occur in association with an increased respiratory rate during conditions of mental stress (Bernardi et al., 2000).

Increased minute ventilation associated with exercise may influence the heart rate variability (HRV) and systolic blood pressure variability (BPV) power spectra analysis resulting in altered physiologic interpretation. Exercise generally has been associated with the withdrawal
of parasympathetic tone and concomitant increase of sympathetic tone in healthy subjects (Task Force of the European Society of Cardiology and North American Society of Pacing and Electrophysiology, 1996.) High (“exercise like”) frequency deep breathing performed at rest does not alter total minute muscle sympathetic nerve activity compared with normal resting breathing (Seals et al., 1990).

Controlled breathing at either 15 breaths per min or at a frequency similar to that of silent reading (i.e., 18 breaths per min) did not change RR mean value and variability and increased the power of the respiratory fluctuations (in relative percentage terms). The power in the LF band was not significantly reduced during controlled breathing. Respiration compared with spontaneous breathing, controlled breathing increased ventilation by 131.9 ± 36.5% (15 breaths per min, p < 0.01) and by 192.2 ± 46.9% (18 breaths per min); the power in the HF band of respiration increased significantly during the slower, but not during the faster, controlled breathing, whereas the respiratory frequency increased only during the faster controlled breathing. Therefore, the increase in ventilation observed during controlled breathing was mainly due to an increase in tidal volume during slower controlled breathing and mainly to an increase in breathing frequency during faster controlled breathing.

However, exercise-induced increased HRV and BPV high frequency power (HF) may reflect increased ventilation rather than reflecting true autonomic changes (Bartels et al., 2003). Further, studies of autonomic modulation during exercise have mostly utilized frequency domain analyses to analyze HRV and BPV power spectra. Such analysis, using Fourier transforms, is most reliably performed on stationary data, which are not present during exercise (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996).
Respiratory rates and tidal volumes during incremental exercise did not produce significant changes in LF and HF power spectra of the HRV or systolic BPV in the presence of normal blood gas homeostasis. Conversely, during incremental exercise, LF and HF power spectra of the HRV significantly decreased while LF and HF power spectra of the systolic BPV significantly increased (Kollai and Miszei, 1990).

Parasympathetic cardiac activity during exercise in healthy subjects has been shown to either remain unchanged (Casadei et al., 1993), or decrease (Yamamoto et al., 1991) while sympathetic activity increases (Macor et al., 1996) findings of decreased LF and HF power spectra of HRV during exercise suggest parasympathetic withdrawal, as changes in parasympathetic activity affect both LF and HF power spectra (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996). The increased LF power spectra of BPV during exercise indicate increased vascular sympathetic modulation (Seals et al., 1990). The increase in HF power of BPV during exercise is in agreement with previous findings by others, although the physiological meaning of these changes in HF is still unclear (Bartels et al., 2003).

The increased HF power spectra of BPV found during exercise in one study does not appear to be the result of a mechanical effect of increased ventilation on decreased heart filling and stroke volume as previously proposed (Cottin et al., 1999), since increased respiratory rates and tidal volumes at rest mimicking exercise-induced ventilator changes did not change HF power spectra of BPV in our subjects. Thus, other factors besides changes in ventilation appear to mediate HF power spectra of the systolic BPV during exercise.
The absence of changes in LF/HF ratio during all stages of both Control Breathing and exercise protocol corroborates its lack of sensitivity as an indicator of autonomic modulation during exercise (Cottin et al., 1999).

(Novak et al., 1995) used time frequency analysis rather than frequency analysis since exercise data do not meet the stationary criteria required for accurate frequency domain analysis. Investigation does not provide a mechanistic explanation for autonomic modulation during exercise. Additional limitation of our study is that we did not have the capacity to measure end-expiratory lung volumes during exercise which theoretically can influence autonomic modulation during relaxation training.

End-expiratory lung volumes increase during incremental exercise in healthy subjects (McClaran et al., 1999). The effect of “exercise-like” respiratory rates and tidal volumes performed at rest on end-expiratory lung volumes remains unknown.

In summary, the findings of this investigation suggest that increases in ventilation do significantly affect spectral analysis of heart rate variability during incremental exercise in normal subjects. Therefore, measured changes in these spectral parameters during relaxation training likely represent true cardiovascular autonomic modulation.

On the other hand, previous investigations showed that altered breathing and talking change HR and the spectral characteristics of HRV. It was also found that respiratory and heart rate variability spectra, from short-term ECGs, are synchronized. Therefore, we assumed that measurement of respiratory rate could not provide any better insight into the apparent discrepancy between HR and spectral HRV changes (Bernardi L, 2000).

Efficient functioning in a complex environment requires a dynamic interplay between SNS and PNS, and this interplay requires adequate prefrontal cortex (PFC) functioning, which is
thought to be involved in the inhibition of SNS activation (Thayer and Lane, 2009). Attenuated SNS and increased PNS influence are associated with a high HRV, particularly the high frequency component (HF), and are associated with higher PFC activity (Lane et al., 2009). Associations between ANS and PFC activity, using HRV and cognitive performance, respectively have previously been reported (Hansen et al., 2007). For example, reported that subjects with high HRV performed better on executive tasks, but did not differ with regard to simple reaction time, compared to low HRV subjects. This is consistent with reports of higher PFC activity correlating with better executive abilities. On the other hand, hypoactivity of the PFC, as detected using cognitive tasks (Garavan et al., 1999), may limit an individual's behavioural capacity to adapt to threats and avoid inappropriate responses. Specific cognitive domains that may be sensitive to reduced PFC activity include executive functions, selective attention and affective responses (Thayer and Lane, 2000). HRV is also associated with physical fitness and maximal oxygen consumption (VO$_2$max) (Kaikkonen et al., 2007). (Hansen et al., 2007) reported that trained male sailors (higher VO$_2$max) showed faster reaction times and higher accuracy in executive tasks after 8 weeks of aerobic training, whereas a paired sailors group who had been de-trained for 8 weeks had no significant change in these tasks. However, the de-trained group, in the post-test condition, had faster reaction times on non-executive tasks. This result led us to postulate that there may be measurable differences in the effects of the divisions of the ANS on cognitive task performance.

Study indicated that, in comparison to mental stress, autogenic training increased R-R intervals and HF power. Autogenic training is a relaxation procedure that has been extensively used in the psychotherapy of anxiety disorders and other somatic or psychosomatic diseases (Manzoni et al., 2008).
It found that autogenic training facilitates HRV and the vagal control of the heart. A previous study similarly reported that healthy volunteers that had been trained to use autogenic training for three months displayed increased R-R intervals and decreased baseline deflection of the plethysmogram (Mishima et al., 1999).

In healthy individuals both short and long-term HRV can be detected, short-term variability is being principally associated with vagal ventilatory modulation of heart rate, and long-term variability resulting from more complex autonomic and neuroendocrine control (Tulppo et al., 1996; Kleiger et al., 2005).

2.7.6 Physiological Background of HRV Analysis

In a normal physiologically and neurally intact heart, successive cardiac cycles (RR intervals) are non-uniformly separated in the time domain. Investigation of this temporal variability in the RR interval data is commonly referred to as heart rate variability (HRV) analysis (Figure.2.8).
The sinus node is densely innervated by both autonomic divisions, and heart rate will reflect their modulating effect on the intrinsic firing rate of its pacemaker cells. Parasympathetic activation slows heart rate. This effect is mediated by synaptic release of acetylcholine, which possesses a very short latency period and high turnover rate. The rapid response of this biological mechanism enables the parasympathetic nervous system to regulate cardiac function on a beat to beat basis.

Figure 2.8: Heart – ECG
Sympathetic activation results in an increase in heart rate and conduction system velocity, together with an increase in contractility. This is mediated by synaptic release of noradrenaline which is reabsorbed and metabolized relatively slowly. Changes in cardiovascular function mediated by alterations in sympathetic activity therefore have a slower time course (Figure 2.9).

Because of these differences in neurotransmitter function the two subsystems of the autonomic nervous system tend to operate at different frequencies and variation in heart rate related predominantly to changes in sympathetic or parasympathetic activity can be identified and quantified. Although the interpretation of this type of data requires some caution, it does provide the basis for non-invasive semi-quantitative assessment of autonomic activity (Jiri et al., 2002).

Traditional opinions advocated that the relationship between two divisions of the ANS was entirely antagonistic. Largely due to these historical view points, research into autonomic specificity was essentially nonexistent until the mid 1980s. More contemporary research into ANS functioning, however describes the two branches as having the ability to behave either in synchrony or independently of one another (Bernston et al., 1991) (Figure 2.10).

2.7.7 R-R Interval

Heart rate variability is quantified by analysis of variations of the intervals between consecutive normal heart beats. The usual definition of a heart beat interval is the time between consecutive R wave peaks. Advances in computer technology allowed sequential R-R intervals to be measured accurately and recorded in real time. After passing through automated ectopic beat and artefact handling procedures, sophisticated and fast methods of analysis can then be
applied to the data to determine HRV measurements which reflect autonomic nervous system activity. Typically, HRV can be measured using add-on software in some standard ECG machines or by dedicated HRV analyzers (Jiri et al., 2002) (Figure.2.11).

In addition to these cyclical variations, there are frequent, sudden large beat to beat changes in R–R intervals that are superimposed on the cyclical changes, and occur throughout the day and night. Sudden beat to beat changes in R–R interval, such as those that occur in association with changes in posture or muscular exercise are abolished by atropine but unaffected by beta-blockers. In animals, beat to beat variation in R–R interval is abolished by vagal section, but returns with direct stimulation of the sectioned vagus. Beat to beat variation in R–R interval is reduced or absent in subjects with parasympathetic neuropathy. Thus the non-cyclical beat to beat variation in R–R interval that occurs constantly in man is thought to be parasympathetically mediated. The spontaneous variation in efferent cardiac parasympathetic activity that generates these constant beat to beat changes is a normal physiological response to afferent inputs from the periphery, higher centres, and other neuroendocrine systems (Jiri et al., 2002) (Figure.2.12).
Figure 2.9: Sympathetic and Parasympathetic Modulation

Figure 2.10: PQRST

Figure 2.11: RRI a
2.7.8 Time Domain Analysis of HRV

These methods use mathematically simple techniques to measure the amount of variability present in a pre-specified time period in a continuous electrocardiogram. After editing to remove non-sinus beats and artefact, the remaining normal to normal R-R intervals are measured and subjected to simple statistical analysis. The most commonly used technique is to plot a histogram of R-R interval duration against the number of R-R intervals in a 24-h period and then to calculate the standard deviation of the frequency distribution (SDNN index). All these indices quantify the total amount of variability present in a 24-h recording, and are influenced by changes in both sympathetic and parasympathetic activity, making them non-specific measures of sympathovagal balance. They are useful clinical tools for detecting abnormalities of autonomic activity, but cannot be used to quantify specific changes in sympathetic or parasympathetic activity (Jiri et al., 2002).

There are a number of techniques available to measure beat to beat RR interval variability, providing interchangeable measurements of parasympathetic activity. One approach is to measure successive beat to beat RR interval differences, and calculate an index that expresses the distribution of these differences such as the rMSSD index, based on the standard deviation of successive differences. An alternative technique is to count the number of large beat to beat changes that exceed a pre-set threshold in a recording. If only beat to beat changes in excess of 50ms are counted (pNN50 index), an index that clearly separates normal individuals
from those with parasympathetic dysfunction is obtained. These indices provide sensitive and specific interchangeable time domain measurements of parasympathetic activity, which are easy to measure in clinical quality ambulatory electrocardiograms (Jiri et al., 2002).

### 2.7.9 Frequency Domain Analysis of HRV

HRV frequency domain analysis could provide some insight into specific autonomic derangements at this premature stage of cardiac dysfunction. Because sympathoexcitation resulting from emotional stress (Pagani et al., 1991).

It is difficult to obtain precise physiological data about changes in autonomic function using relatively unsophisticated time domain analysis of HRV. Because of this, investigators have invested considerable time and effort in developing alternative techniques to investigate cyclical changes in HRV. Before this type of analysis can be performed, extensive editing and review of the electrocardiogram by an experienced operator is required to remove/ edit nonsinus ectopic beats, pauses, tape artefact and non periodic R–R interval changes. Gaps in the R–R interval series associated with data deletion are replaced by interpolating beats using a variety of different algorithms. The edited normal to normal R–R interval series is then analysed using the mathematical techniques of fast Fourier transformation or auto regression analysis, and the amount of cyclical variation present at different frequencies can be detected and quantified. This information is usually presented graphically by plotting the amount of variation present in a recording on the vertical axis against the frequency at which it occurs on the horizontal axis. By measuring the area under the curve at different frequencies (expressed as spectral power) a numerical measure of the amount of high and low frequency cyclical variability present in recording is obtained. Early studies used strictly controlled laboratory conditions to obtain short high quality R–R interval recordings from which accurate frequency domain measurements were
used to explore autonomic activity in animal studies. Frequency domain analysis has also been applied to human 24-h ambulatory electrocardiograms. Although the information obtained has value in risk stratification, the large amount of artefact, ectopy and non-stationary heart rate behaviour that is present in these long-term recordings renders analysis difficult and poorly reproducible (Jiri et al., 2002).

In general, the low frequency (LF) heart rate fluctuation (about 0.1Hz) is related to the vasomotor effect, mediated by the sympathetic nervous system. The high frequency (HF) fluctuation is synchronised with respiration, mediated by parasympathetic nervous system. The ratio of LF to HF fluctuation behaves a sympathovagus balance index. A high LF/HF ratio shows the predominance of sympathetic activities and low ratio for parasympathetic (vagal) dominance (Schroeder et al., 2003).

In normal individuals cyclical changes in heart rate occur in association with respiration. This respiratory related variation occurs at a high frequency (typically around 0.25 Hz or 15 times per minute at rest) and can be abolished by vagal blockade. These two factors suggest that this particular type of high frequency cyclical HRV is parasympathetically mediated. Cyclical variation occurring in association with changes in baroreceptors activity (due to fluctuation in blood pressure) can also be easily identified. This baroreceptor mediated variation occurs at a lower frequency (typically 0.10 Hz or six times per minute) and can be significantly modified by sympathetic blockade. There is also a close correlation between this low frequency variation in heart rate and direct measures of muscle sympathetic nerve activity. These factors suggest that sympathetic activity is an important mediator of this low frequency cyclical HRV. Recently, studies have demonstrated that vagal blockade also produces some modification of this low frequency HRV, suggesting that there is also a parasympathetic component to this cyclical
activity. Because of this dual modulation, measurement of low frequency cyclical HRV does not provide a direct quantitative index of sympathetic activity. Simultaneous measurement of high and low frequency HRV, however, can be used to investigate changes in sympathovagal balance. Since the two arms of the autonomic nervous system operate in a co-ordinated fashion, relative changes in the amount of high and low frequency HRV provide a semiquantitative index of the direction and magnitude of reciprocal alteration in sympathovagal balance (with a high frequency bias suggesting parasympathetic dominance, and a low frequency bias suggesting sympathetic dominance) (Jiri et al., 2002).

Power spectral analysis of HRV for each consecutive 256 s of recording was performed sequentially with a polar Heart rate monitor and HRV software (Polar Co.). Spectral components were identified and then assigned, on the basis of their frequency, to 1 of the 3 bands: very low frequency (VLF; 0–0.03 Hz), low frequency (LF; 0.04–0.15 Hz), and high frequency (HF; 0.16–0.45 Hz). These components were obtained in absolute values of power (ms2). LF corresponds to baroreflex control of the heart rate and reflects mixed sympathetic and parasympathetic modulation of HRV. HF corresponds to vagally mediated modulation of HRV associated with respiration (i.e., respiratory sinus arrhythmia). LF and HF components are always reported in normalized units (nuLF, nuHF), which represent the relative value of the power of each component in proportion to the total power minus the VLF component. Normalized units tend to minimize the effect of the change in total power on the values of the LF and HF components. The LF/HF ratio, an estimate of sympathetic modulation of HRV, was also calculated from the absolute power of both frequency components (Farb et al., 2007). For these HRV indices (nuLF, nuHF, and LF/HF), a logarithmic transformation was performed because of the skewness of the distributions.
These guidelines suggest that three bandwidths are of importance in the power spectra of adult HRV data: (i) very low-frequency (VLF), defined as 0.04 Hz, (ii) low-frequency (LF), defined as 0.04–0.15 Hz and (iii) high frequency (HF), defined as 0.15–0.4 Hz. Physiological interpretation of these components has been suggested by several authors: (i) VLF activity is associated with the thermoregulation of vasomotor tone and with the rennin–angiotensin–aldosterone system; (ii) LF activity is associated with the intrinsic oscillations of the baroreceptor reflex (i.e. blood pressure fluctuations); (iii) HF activity is associated with heart rate modulation via the influence of respiration. Neural regulation of the heart rate takes place as a result of the interplay between sympathetic and parasympathetic modulation of the electrical activity of the sinoatrial (SA) node. These two branches of the autonomic nervous system (ANS) are said to demonstrate a reciprocal activity relationship (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996).

A fundamental hypothesis suggesting the use of spectral analysis in HRV studies is that the two branches of the ANS influence the heart rate in a frequency-dependent way. These studies have suggested that: (i) the high-frequency (HF) components of the HRV signal are mediated via the parasympathetic system, the sympathetic system being too slow to respond at these frequencies, and (ii) HRV components in the low-frequency (LF) range are mediated via both sympathetic and parasympathetic systems. Additionally, it has been suggested that the relative power of the LF and HF components (the LF/HF ratio) might provide an accurate index of sympathovagal balance (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996).

It has been shown that respiratory sinus arrhythmia (RSA), modulation of SA node activity via respiratory frequency and volume, is the main mechanism influencing the HF
components of HRV. Indeed, the central frequency of RSA in HRV analysis has been shown to correlate strongly with respiratory frequency (Bernardi et al., 1989).

Low-frequency (LF, 0.05-0.15 Hz) and high-frequency (HF, 0.15-0.40 Hz) heart rate variability were measured in this study.

Some authors suggest that the LF/HF ratio may index sympathovagal balance, reflecting the relative operating point on a continuum from parasympathetic to sympathetic dominance. Recent papers argue that the LF/HF ratio is a confounded measure, because: (1) sympathetic and parasympathetic activity can vary independently and (2) parasympathetic contributions to LF and HF variability derive from partially different mechanisms — blood pressure-baroreflex vs. respiratory, respectively (Berntson et al., 1997).

Some time and frequency domain HRV measurements are closely related. Indices that measure beat to beat parasympathetically mediated HRV (rMSSD, sNN50 and high frequency power) and measures of the total amount of variability present in a long-term recording, such as SDNN and total spectral power, are strongly correlated. These time and frequency domain indices can therefore be used interchangeably (Jiri et al., 2002).

Heart rate variability (HRV) analysis in the frequency domain is a valuable method to determine quantitatively the sympathetic and parasympathetic modulations of heart rate (HR). Two main spectral components are the most commonly distinguished in the HRV spectrum, that is, low frequency (LF) and high frequency (HF) components. These quantities can be presented in different units: millisecond squared (ms²), beats per minute squared (bpm²), or normalized units. The ms² implies that the spectrum has been obtained from an R-R interval sequence whereas the bpm² means that the spectrum has been calculated from a sequence of instantaneous heart rates (IHRs) (obtained by inversion of the R-R interval sequence. The normalized units
correspond to LF and HF given as a percentage of the total power (TP) (usually defined as a sum of LF and HF). The normalized quantities may originate from a spectrum expressed in both ms$^2$ and bpm. Low-High frequency ratio and TP defined as a sum of LF + HF as well as normalized values, that is, nLF and nHF (where nLF = LF × 100/(LF + HF), nHF = HF × 100/(LF + HF)), were also determined (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996).

The use of time domain measurements to delineate autonomic modulation of the heart rate is useful because time domain measures do not require the rigorous acquisition and analysis criteria, i.e. stationarity, when compared to frequency domain analyses. Although body fat percentage may be an important determinant of heart rate variability spectral power measured at rest (Chen et al., 2008).

Studies showed that among trained subjects increased HRV seems to be associated with the improvement in maximal oxygen consumption (Loimaala et al., 2000). A recent report documented that in frequency domain analysis interpolation performs better than deletion leading to smaller errors in the editing process of especially 24-h registrations (Salo et al., 2001). The following time domain indices were determined: mean of all normal RRIs, SDNN (standard deviation of normal RRIs), RMSSD (root mean square of successive difference of normal RRIs) and pNN50 (percentage of RRIs differing more than 50 ms from the previous RRI). In frequency domain analysis the power spectrum was divided into four different bands. The following variables were calculated: total power (V0.4 Hz), ultra low frequency (ULF) power (V0.003 Hz), very low frequency (VLF) power (0.003–0.04 Hz), low frequency (LF) power (0.04–0.15 Hz) and high frequency (HF) power (0.15–0.4 Hz) in ms$^2$ (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996).
Spontaneous heart rate (HR) variability has been studied extensively in recent years in diverse clinical conditions (Malik et al., 1996). The low frequency heart rate variability peak at 0.04–0.15 Hz is related to baroreflexes and represents sympathetic and parasympathetic activity. The high frequency peak at 0.15–0.4 Hz is related to respiration and represents parasympathetic activity (Malik et al., 1996).

2.7.10 Definition of Heart Rate Variability Parameters

2.7.10.1 Time Domain Parameters

- RRIs- The mean R-R interval duration (ms).
- SDNN index- mean of the standard deviation of all normal sinus R–R intervals for all 5-min segments
- RMSSD- Root mean square of successive difference of normal RRIs
- pNN50 - percentage of RRIs differing more than 50 ms from the previous RRI

2.7.10.2 Frequency Domain Parameters

- Low Frequency (LF) = The power (0,04–0,15 Hz) in ms²
- High Frequency (PH) = power (0,15–0,4 Hz) in ms²
- LF/HF Ratio- The ratio of LF to HF
- nLF- normalized values of LF
- nHF- normalized values of HF
- nLF/nHF- normalized values of LF/HF

Spectral components were expressed both as absolute values in milliseconds (Yamamoto et al., 1991; Volterrani et al., 1994) and as normalized units (nu), which were calculated as follows: (absolute power of the components)/(total power – VLF power) × 100 (Bernardi et al.,
Power spectra at the frequency of 0.15–0.4 Hz are defined as the high-frequency (HF) components and are representative of parasympathetic modulation. Power spectra within the 0.04–0.15 Hz range are defined as low frequency (LF) components and are representative of sympathetic and parasympathetic vasomotor modulation.

Power spectra within the 0.04–0.15 Hz range were defined as LF components. The ratio of LF to HF has been suggested to reflect the sympathovagal balance (Pagani et al., 1991).

The normalized LFnu (HFnu) power was calculated by dividing the absolute power by the total power (defined as the sum of each spectral component) and multiplying by 100. The LF/HF ratio was calculated from the absolute values of the LF and HF power for each subject and is considered by some (Pagani et al., 1986; Lanza et al., 1997).

In a study by (Kubo et al., 1996) in which 47 patients with ischemic heart disease were required to 1) lie resting for 15 min, 2) listen to music for 20 min, and then 3) lie resting for 15 min, in that order, the HF component increased when the patients were listening to selected music of their preference (classic, jazz, popular, and music box music) and continued to increase over the subsequent 15 min of rest, and LF/HF was lower after listening to music than before resting, suggesting that parasympathetic nervous system activity is enhanced by music.

(Yasumoto et al., 2001) had 7 female students 1) sit with their eyes open for 5 min, 2) breathe abdominally 6 times for 1 min while sitting with their eyes closed, 3) do a mental concentration exercise for 5 min while sitting with their eyes closed, 4) listen to 1/f music for 4 min and 30 sec, 5) do a mental concentration exercise for 5 min, and 6) meditate for 30 min, in that order. The HF% was scored using sitting as the standard. It was found that HF% variation every 10 min after listening to 1/f music increased, indicating that listening to music stimulated parasympathetic nervous system activity.
(Davis and Thaut, 1989) observed that when preferred music decreases anxiety and brings about relaxation, heart rate, vascular constriction, peripheral skin temperature, and muscle activity are stimulated rather than depressed. (Shimomura et al., 1997) measured electroencephalogram, respiration, and pulse rate after listening to preferred music and found that listening to music resulted in excitation of the sympathetic nervous system, as indicated by an increase in respiration and pulse rate, regardless of the type of music (stimulating or calming).

On the other hand, the above previous researches suggest that music affects the parasympathetic nervous system were based on listening to music after resting. It is possible that maintaining a resting state for a certain length of time brings about a biological response in which the parasympathetic nerves tend to dominate in association with a calming of mood and that subsequently listening to music further promotes the response, thereby increasing parasympathetic nerve activity. It appears that music that is in synchrony with a person's mood at the time promotes a psychological response that leads to physiological changes regardless of whether the person is in an activated or calm state. The fact that a previous study showed no difference in LF/HF for music, bird song, and mechanical sounds produced with a synthesizer as sound stimuli suggested that the sympathetic nervous system was not affected by sound (Yanagihashi et al., 1997). This was probably because the sound stimuli were presented for only a short period (5 min) and because sound, unlike music, does not give rise to responses that involve emotions, such as memories and images.

2.7.11 Music and Meditation on Heart Rate Variability

Since sedative music is thought to have a relaxing effect, it is assumed to activate the parasympathetic nervous system (PNS) and inactivate the sympathetic nervous system (SNS). That is, sedative music might increase the HF component. (Iwanaga and Tsukamoto, 1997)
These results indicate that PNS activity is related to music's relaxing effect. As such, the HF component as a measure of PNS is considered a good index of the sedative effects of music. However, it is difficult to extract SNS activity from HRV independently, because the LF component represents the combined activities of the SNS and PNS. (Hayano et al., 1991) proposed the LF/HR ratio as a measure of SNS. Since (Yanagihashi et al., 1997) found that noises such as mechanical sounds increased the LF/HR ratio, they concluded that the LF/HR ratio might serve as an index of SNS activity.

HRV, on the other hand, was sensitive to differences in experimental conditions. The LF component and the LF/HF ratio increased during EM and SM but decreased during NM. Because the LF component and the LF/HF ratio for both sedative and excitative music showed patterns contrary to those of the control, these two indices might reflect the existence of musical stimuli. Since the LF/HF ratio is considered to reflect SNS activity (Hayano et al., 1991), musical stimuli might also help activate SNS.

On the other hand, the HF component was higher during SM than during EM, but it was the same between SM and NM. This pattern was similar to those of the changes in perceived relaxation. Therefore, the most sensitive index of music's relaxing emotional effect may be the HF component of HRV, which is considered to reflect PNS activity. Excitative music decreased PNS activation. These results regarding HRV support the findings of previous studies (Iwanaga and Tsukamoto, 1997). Since the HF component of HRV was reduced during stress tasks (Dishman et al., 2000) and by mechanical sound (Yanagihashi et al., 1997), the HF component is decreased by stress and uncomfortable stimuli. Therefore, the HF component may be sensitive to stress elicitation and reduction. The HF component during SM was the same as that during NM. The decrement of HF was observed during EM. These results show not that sedative music increases PNS activity, but that excitative music may decrease it. However, the difference in
PNS activity between the sedative and excitative pieces was observed in the first session but not in the third or fourth. The HF component for excitative music gradually increased, even though the increase was not statistically significant. The same pattern was found in perceived relaxation for excitative music: a gradual increase with repeated exposure. In contrast, the HF component and perceived relaxation for sedative music remained nearly the same regardless of repeated exposure. The differences between sedative and excitative music narrowed through repetitive exposure. Although excitactive music may facilitate musical tension and decrease PNS activation at first, repetitive exposure to excitactive music may induce relaxation mentally and physically. Music, unlike the no-music control, may increase both SNS and PNS activity. The no-music control may increase only the PNS and decrease the SNS. Although the same relaxed moods were elicited by both SM and NM, the balance of the ANS differed between these two conditions.

Kayoko et al., (2005), examined whether music affects the exercise-induced changes in the autonomic nervous system activity. Music was given according to subjects' preferences using a vibroacoustic apparatus (body sonic system), i.e. a chair on which subjects laid and felt low-pitch sounds by their body in addition to listening music. With music, the ratio of low frequency to high frequency component of heart rate variability (LH/HF) was significantly increased after exercise as compared with before exercise. By contrast, the changes in LH/HF were not significant without music. It is suggested that after exercise in which sympathetic nerve activity is dominant, preferred music synchronizes with the activated physical response, further promoting the response and increasing sympathetic nerve activity. Combining music with exercise is therefore not only enjoyable in terms of mood but also may promote physiological excitation and enhance physical activation (Mulcahy et al., 1990).
(Yasumoto et al., 2001) had 7 female students 1) sit with their eyes open for 5 min, 2) breathe abdominally 6 times for 1 min while sitting with their eyes closed, 3) do a mental concentration exercise for 5 min while sitting with their eyes closed, 4) listen to 1/f music for 4 min and 30 sec, 5) do a mental concentration exercise for 5 min, and 6) meditate for 30 min, in that order. The HF% was scored using sitting as the standard. It was found that HF% variation every 10 min after listening to 1/f music increased, indicating that listening to music stimulated parasympathetic nervous system activity.

(Furlan et al., 1993) showing higher LF values in supine rest in trained athletes and support the hypothesis that daily exercise training could lead to an increase in the sympathetic modulation of the sinus node at rest, possibly as an after-effect of vigorous exercise routine, constituting a part of cardiovascular exercise conditioning. This enhanced sympathetic modulation of sinoatrial activity in trained athletes may occur even in the absence of significant exercise-induced changes in resting heart rate (i.e. without a bradycardic effect) reason why it is high in base line.

Developmental evidence has shown that high levels of HRV and cardiac vagal tone are associated with adaptive responsivity to the external environment. For example, the ability to sustain attention and avoid distraction is positively correlated with vagal tone in infants and children (Richards et al., 1992). A network of CNS structures serves as the foundation of these processes that organize response variability and modulate psychophysiological resources in attention and emotion. Infants with low HRV also display impoverished stimulus responsivity and poor emotional control (Fox, 1989). Thus, HRV indices seem capable of assessing vital developmental aspects of self-regulatory behavior due to the capacity of HRV to reflect neural feedback mechanisms of CNS-ANS integration.
Thus the analysis of HR variability holds great potential for the investigation of pre-competition anxiety. This technique has revealed an autonomic substrate for the symptoms of panic that has long eluded researchers.

2.7.12 Comparison of Time and Frequency Domain Techniques for Analysis of HRV

The HRV technique chosen for a particular study will depend on a variety of different factors. Frequency domain techniques facilitate a more precise evaluation of the direction and magnitude of changes in sympathovagal balance than is possible with time domain analysis. Accurate assessment of autonomic activity by frequency domain techniques require that heart rate data are free of artefact and obey strict mathematical criteria, conditions that can only be reliably obtained when subjects are studied under controlled conditions. Since time domain techniques do not have such strict requirements, they are easier to apply to the study of clinical quality ambulatory electrocardiograms (Jiri et al., 2002).

Most of the beat to beat variation in the heart rate arises from fluctuations in the parasympathetic (PNS) and sympathetic nervous system (SNS) input to the sinoatrial node. Spectral analysis of HRV can provide quantitative information on the relative contribution the PNS and SNS influences the neural control of heart rate. High frequency power (0.15 to 0.5 Hz) has been attributed to the PNS, with respiration being the primary rhythmic stimulus. Low frequency power (< 0.15 Hz) is thought to reflect both SNS and PNS influences. It was hoped that HRV frequency domain analysis could provide some insight into specific autonomic derangements at this premature stage of cardiac dysfunction. Because sympathoexcitation resulting from emotional stress (Dighton, 1974) (Figure.2.13).

In the last decade a series of complex techniques have been developed to provide additional information over and above that available from standard time and frequency domain
analysis of HRV. Investigators have recently reported on new time domain techniques that provide some information on sympathetic activity.

**Figure 2.13: Autonomic Nervous System**

The techniques of peak through analysis, complex demodulation and acceleration–deceleration oscillation analysis are closely related and based on similar principles. Post ectopic turbulence analysis may prove useful as a non-invasive index of cardiovascular reflex integrity. Analysis of beat to beat QT interval variability may emerge as a useful quantitative index of sympathetic activity if reliable methods of correcting for changes in heart rate can be developed. The use of non-linear dynamics or chaos analysis for evaluation autonomic control processes has
also been investigated in normal subjects and patients with cardiovascular disease. The techniques can be applied to clinical quality ambulatory electrocardiograms, but they are mathematically complicated and have yet to be extensively validated or applied to clinical investigations. Further research and more consistent evidence based on larger studies is needed before these techniques can be incorporated into routine practice (Jiri et al., 2002). SDNN, LF power, HF power, and the LF/HF ratio as the most prominent time domain and frequency domain parameters, respectively. Although the use of time domain parameters has been recommended by the task force for long-term electrocardiograms only, several studies have demonstrated good predictive ability of SDNN also from short-term electrocardiograms.

2.7.13 HRV on Circadian Rhythm and Positional Changes

2.7.13.1 Circadian Rhythm

The role of the autonomic nervous system in regulating cardiovascular circadian rhythms has also been evaluated, with HRV studies demonstrating sympathetic dominance in the morning, but parasympathetic dominance at night. This early morning increase in sympathetic tone may be a trigger for the cascade of pathophysiological changes.

Interestingly, a rapid spontaneous vagal withdrawal in the morning seems to be a sign of a healthy autonomic control. The physiology of normal ageing can also be explored, with a progressive decline in sympathetic and parasympathetic activity occurring in association with increasing age. Measurement of HRV may be of prognostic value even in individuals who are free of overt clinical disease, with low values identifying those at increased risk of premature cardiac disease (Furlan et al., 1990).

HF measures reached the greatest values in the night. At the same time, LF/HF night values were the smallest ones. (Huikuri et al., 1990) were the first researchers to report the clear circadian rhythm of HRV parameters in healthy people. Similar to our study, they observed the
greatest values of HF in the night and the greatest values of LF/HF during the day. In contrast, we did not find a circadian pattern of LF values as reported by Huikuri et al who observed the smallest LF values in the night. They also reported significant hour-to-hour HRV changes and downfall of LF values between 5 and 9 am.

HRV indexes have been determined under various conditions of observation. Taking as an example the field of sports science, HRV has been generally examined during short-term supine wake periods under spontaneous or controlled breathing (Buchheit et al., 2004).

Further environmental and physiological factors, such as temperature, position, respiration rate, circadian rhythm and/or postprandial changes, physical exercise, etc. (Bellavere et al., 1996; Bottini et al., 1995; Howorka, Pumprla, Haber, et al., 1997; Howorka et al., 1997), might play a role in autonomic control, as well, and it is therefore preferable to evaluate the autonomic control in response to a standardized manipulation protocol rather than in a single, steady position (Keselbrener and Akselrod, 1998).

To avoid excessive distraction and to be given a minimum of 15 min alone with their handler to become acclimatized to the room prior to recording their heart rates. Beat to beat variability in heart rate is a function of many external inputs, orchestrating their influence on the heart rate via the PNS and SNS. Fluctuation in PNS activity, however, is the major mechanism for HRV. Rate and depth of respiration, blood pressure, the baroreceptors, the renin-angiotensin-aldosterone system (RAAS), Thermoregulation, and higher centers of the central nervous system all have an effect on heart rate variability. In addition, circadian variation, age, emotional state, level of physical fitness, fasting, sleeping and body position all modify normal HRV at any given point in time in healthy individuals (Pagani et al., 1991).

We cannot live without circadian rhythms because they are the adaptations that our body makes to protect itself against environmental factors. Setting of the rhythm for everyday life is
directed by a molecular biological clock situated in the brain’s suprachiasmatic nucleus (SCN). It is under the strong influence of the daily cycle of light and darkness and the plasma melatonin levels secreted by the pineal gland. A clinical event occurs when our autonomic nervous system is not able to control the adverse effects of these adaptations. Triggering of the SCN due to environmental factors may activate the pineal gland, pituitary function and adrenal secretion, resulting in adverse effects as regards circadian variation, heart rate variability (HRV) and blood pressure variability (BPV). It should be noted that the role of circadian variation and chronotherapy was also known to the ancient Indian physicians (Mehta et al., 1998).

The role of the autonomic nervous system in regulating cardiovascular circadian rhythms has also been evaluated, with HRV studies demonstrating sympathetic dominance in the morning, but parasympathetic dominance at night (Ewing et al., 1991). This early morning increase in sympathetic tone may be a trigger for the cascade of pathophysiological changes underlying the increase in acute cardiac events during the first few hours of the morning (Furlan et al., 1990) interestingly; a rapid spontaneous vagal withdrawal in the morning seems to be a sign of a healthy autonomic control. The physiology of normal ageing can also be explored, with a progressive decline in sympathetic and parasympathetic activity occurring in association with increasing age. Measurement of HRV may be of prognostic value even in individuals who are free of overt clinical diseases. This showed the relationship between cortisol and HRV rise early morning.

2.7.13.2 Positional Changes

More recently, advances in technology have facilitated rapid on-line frequency domain analysis of HRV during a modified orthostatic test where the individual lies supine for 5 min, stands for 5 min and lies supine again for another 5 min. The autonomic system responds to changes in posture via blood pressure receptors in both the lungs and arterial system (as well as
to barometric receptors in the lungs). Hence this postural test provides a method of evaluating the individual’s autonomic response to standardised changes in position and the associated changes in blood pressure. These short recordings, obtained during controlled conditions, are relatively free of noise and artefact, simplifying the analytical process. The result of this examination protocol is displayed in the form of a three-dimensional graph of frequency (x-axis) plotted against time and spectral power. This type of analysis generates an easily understood visual representation of heart rate variations occurring during the examination. A clear predominance of parasympathetic (high frequency) activity during supine positions and its reduction during standing where mostly ‘sympathetic’ (low frequency) autonomic activity predominates. In the early stages of autonomic dysfunction parasympathetic activity is reduced. In severe autonomic dysfunction, activity in both subsystems (high and low frequency bands) reduces by a number of magnitudes. In addition to the visual representation, normal ranges for high and low frequency activity (spectral power) during the three periods of the orthostatic test have been established to allow the rapid identification of autonomic dysfunction. This type of rapid online analysis facilitates the clinical application of frequency domain techniques while meeting technical and clinical prerequisites for meaningful power spectral analysis of heart rate variability (sufficient length of signal (at least ten times the wavelength of the lowest frequency component), stationarity of data in each position due to controlled examination conditions, relative ease of test performance including artefact processing due to restricted duration of recordings and minimum dependence on the co-opration of the subject).

The time frequency distribution (upper) and the instantaneous low and high frequency power (lower) of the heart period signal shown in (Figure. 2.14). The spectra and spectral power during transient segments (between 10 s before and 40 s after postural changes) are not shown. Sup, supine; Sit, sitting; Sta, standing; Wal, walking (Hsiao-Lung Chan, 2007).
(Vesna et al., 2005), all subjects were examined under the same conditions: in a quiet surrounding and during day hours (between 10 am and 1 pm). All subjects were nonsmokers and were instructed not to drink caffeine beverages prior to ECG recordings. ECG recordings were taken in supine and standing postures. Every subject was in supine posture for 10 min before undergoing 5 min of ECG recording. The same subject then stood up, and after 2 min of blood pressure equilibration (Abi-Samra et al., 1988), ECG was recorded for 5 min. During the recordings, subjects were asked to breathe normally. Origin 5.0 computer program was used to identify and label R wave and to perform frequency domain analysis. Fast Fourier transformation and power spectrum density was calculated using 256 consecutive R–R intervals within 5-min recordings, which demonstrated sinus rhythm and stationarity. Sampling interval was 250 ms as recommended by (Berntson et al., 1997). The power spectrum was then integrated over the frequency bands as described in (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996). Two spectral measures were calculated: low-frequency (0.04–0.15) Hz (LF) and high-frequency (0.15–0.5) Hz (HF) power, and low-frequency-to-high-frequency power ratio (LF/HF) was determined. All the subjects in standing position had an increased heart rate. In the majority of the subjects (55 of 82), an increased heart rate in standing position was accompanied by a decreased high frequency power. In others, an increased heart rate was accompanied by an increased high-frequency power during standing (Vesna et al., 2005).
Hsiao-Lung Chan et al., (2007), reported the larger HF power and lower LF/HF ratio during supine and sitting than standing suggest higher parasympathetic mediation and vagal dominance during supine and sitting, and a withdrawal of vagal activity when the posture was changed to standing. This is concordant with the general physiological response. Some researchers pointed out that the increased respiratory activity for increased metabolic need during exercise would be responsible for the maintenance of HF modulation. Therefore, the decreased LF/HF ratio from standing to spontaneous walking in this study may be attributed to increased vagal predominance (autonomic effect), or be linked to the maintenance of HF modulation due to the increased respiratory activity (Mechanical effect) (Hsiao-Lung Chan et al., 2007).

Data in the literature, although sometimes conflicting, show that there is a progressive maturation of the autonomic nervous system after birth. Some authors describe a gradual
increase of parasympathetic relative to sympathetic mediation in the first 6–10 years of life followed by a gradual decrease (Shannon et al., 1987).

There is a progressive evolution of HRV variables partially related to the subject’s age (Silvetti et al., 1998) and sex, and this can explain some difference with the results of other works. Mean cycle length, SDNN and SDANN were significantly higher in males. A significant inverse association between body weight and BMI and HRV was described in healthy men.

2.7.14 Long Vs Short HRV

Historically, HRV has been measured using both 24-h holter recordings and shorter recordings, most commonly between 2 and 5 minutes in length. While there were initially questions about the accuracy of these shorter recordings. It is now recognized that HRV from records of 2-5minute duration can be used to accurately assess cardiac autonomic activity. Furthermore, there has been interest in using ultra short recording from the standard 12-lead ECG to capture time domain measures of HRV. These records are 10seconds in duration and much easier to collect in clinical and epidemiological settings. However, the ability to make full use of HRV measures derived from both short and ultra short term recordings is limited by the sparse data on the short term repeatability of these measures in healthy populations. This study recommend using records at least 5minutes in duration, when possible in accordance with the previous guidelines. In large scale epidemiologic studies where loner records are unavailable, it may be possible to use time domain measures derived from a single 10 second recording. However, researchers using 10 second records should consider taking the mean of several recordings. If only a single recording is available, researchers should strongly consider statistical methods to adjust for the considerable measurement error (Task Force of the European Society of Cardiology and North American Society of pacing and electrophysiology, 1996).
Although 24-h ambulatory electrocardiograms are commonly used for HRV studies, the optimal time period required to obtain useful data has not been determined, with some investigators reporting that clinically useful information can be obtained from recordings as short as 5 min (Bigger, 1993; Sloan et al., 1994). Moreover, short, 2-15-min samples are excellent predictors of mortality and are correlated with prognostically important data from sustained recording periods (Urakawa et al., 2003). This suggests that frequency domain measurements obtained from short recordings (particularly when conditions are standardised by using the modified orthostatic protocol), may prove to be useful without requiring a long-term electrocardiogram (Jiri et al., 2002).

Recent advances in computing hold out the possibility of fully automated signal processing which will facilitate rapid, reliable and reproducible HRV analysis with minimal operator input, increasing clinical accessibility.

Heart rate variability is controlled by the autonomic nervous system and affected by external and internal factors, such as physical activities and locomotion, circadian rhythm and psychological influences. It is suggested that if the Polar data were found to be free of artifacts or if any anomalies present were carefully identified and corrected, then the Polar RR recorder could reliably be used in place of the gold standard ECG.

A potential limitation of tests based on 24-h recordings is that it is not possible to standardise the conditions for the examination. This may be of particular importance, since recent studies indicate that physical activity is a major contributor to the lowest frequency components of HRV. Despite this, these techniques are highly reproducible in a variety of different clinical situations. Although 24-h ambulatory electrocardiograms are commonly used for HRV studies, the optimal time period required to obtain useful data has not been determined, with some investigators reporting that clinically useful information can be obtained from
recordings as short as 5 min. Moreover, short, 2–15-min samples are excellent predictors of mortality and are correlated with prognostically important data from sustained recording periods. This suggests that frequency domain measurements obtained from short recordings (particularly when conditions are standardised by using the modified orthostatic protocol), may prove to be useful without requiring a long-term electrocardiogram (Jiri et al., 2002).

2.7.15 HRV Clinical Importance

Analysis of HRV was first used in clinical practice almost 40 years ago. The last two decades have seen increasing exploration of the potential clinical value of HRV analysis.

Epidemiological studies have described some of the population correlates of these measures and have demonstrated that low HRV predicts post MI mortality, incident coronary heart disease, incident Hypertension, and all cause mortality.

Measurements of HRV have been used to assess autonomic function in a variety of non-cardiac diseases. Measurement of HRV is superior to reflex testing for the detection of autonomic neuropathy. Diabetic patients with detectable autonomic neuropathy have a substantially increased risk of premature death. Reduced HRV in a type 1 diabetic subject is an early sign of systemic diabetic complications. In type 2 diabetes with autonomic neuropathy, an additional risk related also to other aspects of metabolic syndrome accounts for up to four-fold risk of cardiovascular death when compared with non-diabetic individuals.

More than half of all patients with end stage renal disease have detectable autonomic neuropathy. Metabolic derangement in chronic liver disease and / or hypoxia in chronic respiratory disease can also induce autonomic abnormalities leading to reduced HRV. It is not surprising that disorders of central and peripheral nervous system are also associated with autonomic dysfunction leading to abnormalities of HRV. Also abnormal autonomic function tests are common in some other systemic diseases, such as HIV infected individuals.
A progressive reduction in HRV occurs in patients on intensive therapy units who develop brain death. This phenomenon may help to identify candidates for organ donation. In diabetes, renal, hepatic and neurological disease, improvement in metabolic or neurological function is commonly associated with a return to a normal HRV pattern. A similar effect was seen after physical training in individuals with autonomic dysfunction. Analysis of HRV may also have a clinical role in occupational health, for example when exploring elevated cardiovascular risk in shift workers or in evaluation of associations between ambient pollution levels and cardiovascular function.

Acute myocardial infarction is associated with adverse changes in autonomic activity, which can be easily detected and quantified by measuring different components of HRV. Patients who have marked autonomic dysfunction leading to reduced time or frequency domain measurements of HRV are at increased risk of premature death. Reduced HRV may be more sensitive and specific in CHF than in post-MI patients, suggesting a more important clinical role for HRV analysis in heart failure population. Patients with hypertension have detectable changes in HRV, reflecting adverse autonomic modification that may play an important role in the pathophysiology of the disease.

Transplanted hearts show detectable HRV despite iatrogenic denervation, which may be due to indirect effects dependent on the starling mechanism or variation in circulating catecholamine levels.

2.8 Importance and Scope beyond Sports by Current Study

Depression/stress is a common problem, affecting about 121 million people world-wide. Depressive disorder is characterised by a marked lowering of self-esteem and feelings of worthlessness and guilt. A persistent low mood leads to changes in appetite, sleep pattern and overall functioning. Symptoms further include anhedonia, fatigue and impaired concentration. At
its worst, depression can lead to suicide, which is associated with the loss of 1 million lives per year. Depression is projected to become the leading cause of disability and the second leading contributor to the global burden of disease by the year 2020. It occurs in persons of all genders, ages, and backgrounds (WHO, 2001). The huge personal and economic impact of depression implies a need for systematic reviews of the evidence for efficacy for all current treatment modalities.

Depression is also one of the most common reasons for the use of complementary and alternative therapies (Ernst, 1998). The reasons for this are complex and vary according to client group. They may entail a lack of satisfaction with conventional treatments, and/or a wish to avoid side-effects from medication or the stigma attached to seeking talking therapy. In the case of music therapy, people may feel more able to access this medium as listening to or playing music in other contexts has been felt by the individual to be beneficial. Music therapy might also be indicated for populations who have difficulties in using words, such as those with a learning or physical disability. Music therapy might also be used where non-directive talking therapies are considered inappropriate, for example where depression is secondary to a psychotic illness or severe personality disorder.

In the present study, we used a meditation which is a common mindfulness meditation practice that does not require any special training, as only sustained attention and breath control are needed and Darbari ragas for music therapy. We analyzed changes in endocrine parameters salivary cortisol and autonomic nervous activity using heart rate variability (HRV) as an index.