THE EFFECT OF SOMATIC AWARENESS EXERCISE ON THE CHRONIC PHYSICAL MANIFESTATIONS OF THE STRESS RESPONSE

By

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DECLARATION

I hereby declare that the dissertation submitted for the Master Philosophiae degree to the University of Johannesburg is my own work and has not been submitted to another institution of higher education for a degree. Any help received has been recognised and referenced accordingly.

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______________________________
Witness (Name and Signature)
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ABSTRACT

Stress is an integral part of daily living and supports the ability to adapt. However, chronic activation without the ability to express the physical response results in overloading the physiological and psychological systems. Since urban South Africans are sedentary and experience high levels of stress, they are developing stress related chronic conditions and hypokinetic diseases (obesity, hypertension, depression). This study is aimed at decreasing the chronic physical manifestations of the stress response through somatic awareness exercise and aerobic exercise. The present investigation made use of a quantitative, comparative experimental research design over an eight-week period using pre- and post-tests. Participants were measured for psychological stress via a perceived stress scale and the chronic physical manifestations were measured via heart rate, blood pressure and body sway. The number of volunteers in the present study was 102 and they were recruited from corporate environments in the Johannesburg area. Their ages ranged from 18 to 65 years. The sample consisted of females (n = 42; % = 75) and males (n = 14; % = 25); white (n = 39; % = 69.6), black (n = 12; % = 21.4) and Indian (n = 5; % = 8.9) participants and non-smokers (n = 41; % = 73.2) and smokers (n = 15; % = 26.8). Untrained individuals were divided into 4 groups: a somatic awareness exercise (n = 9), aerobic exercise (n = 15), combination of somatic awareness and aerobic exercise group (n = 8) and a control group (n = 15). The aerobic group participated in aerobic activity, somatic awareness group in somatic awareness exercise and the combination group participated in both aerobic- and somatic awareness exercises. Individuals who trained were placed in a separate exercise group (n = 9) and had to add somatic awareness exercises to their weekly routines.

Statistical analysis utilised descriptive statistics, independent and dependant paired t-tests, One-Way Anova, post-hoc comparatives and size of effect tests were conducted. The independent t-test and the paired t-test were utilised to determine the significance [at a 95% confidence level (p = 0.05)] of the measures from the pre-test to the post-test in stress perception, blood pressure, heart rate and body sway. An independent t-test revealed significant changes for subjective stress perception in the aerobic-, somatic-, combination- and exercise group with a 95% confidence level in comparison to the control group, with the somatic awareness group and combination group having the highest effect sizes. There were no statistically significant differences in the control-, aerobic-, combination- or exercise group for objective measures (blood pressure, heart rate and body sway values). There were statistically significant decrements from the pre-test to the post-test in the somatic group for blood pressure, heart rate
and body sway. Somatic awareness exercise in this regard was successful in reducing subjective and objective stress measures in comparison to other modes of exercise. However, since one’s perception of exercise mode is effective in reducing subjective scores, any exercise modality is effective in providing relief from stress. Somatic awareness may be utilised as a coping tool for stress and from the decreased cardiovascular measures, one may decrease and prevent the chronic physical manifestations of the stress response in a Biokinetic setting.

Key words: somatic awareness, kinaesthetic awareness, stress, exercise, biokinetic, physical activity, Biokineticist, aerobic exercise
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LIST OF ABBREVIATIONS

ACSM - American College of Sports Medicine
ACTH - Adrenocorticotropic hormone
AIDS - Acquired immunodeficiency syndrome
ANOVA - Analysis of Variance
bpm - Beats per minute
cm - Centimetres
CNS - Central nervous system
CRF - Corticotropin releasing factor
DBP - Diastolic blood pressure
DVD - Digital video/versatile disc
EEG - Electroencephalography
G.A.S. - General Adaptation Syndrome
GABA - Gamma-Amino Butyric Acid
GST - General Systems Theory
HPA - Hypothalamic pituitary axis
kg - Kilograms
mmHg - Millimetres Mercury
MRI - Magnetic resonance imaging
n - Sample size
p - p-value for statistical significance
PNS - Parasympathetic nervous system
RHR - Resting heart rate
SD - Standard deviation
SMA - Sensory-motor amnesia
SNS - Sympathetic nervous system
STATKON - Statistical Consultation Services
SBP - Systolic blood pressure
CHAPTER 1

INTRODUCTION AND AIM OF THE STUDY

1.1 Introduction

Stress is a natural part of the life of every human being, and it is necessary for human functioning and adaptation. However, chronic exposure to stress can be detrimental to one’s physiological and psychological functioning, and result in chronic stress related diseases (Everly, 1989; Everly & Lating, 2002; Selye, 1974, 1976; 1978). Chronic stress related diseases affect all age groups and include: psychosomatic disease, fibromyalgia, other pain syndromes, depression, obesity, anorexia (Glei, Goldman, Chuang & Weinstein, 2007), chronic fatigue syndrome, cardiovascular diseases (hypertension), diabetes, inflammatory and autoimmune disease (rheumatoid arthritis), gastrointestinal disease and musculoskeletal disorders (muscular pain, spasm and loss of balance) (Black, 2003; Steyn, 2007; Stojanovich & Marisavljevich, 2008) and may even lead to death (Kozora, Ellison, Waxmonsky, Wamboldt & Patterson, 2005).

1.2 Prevalence and economic impact of stress

Worldwide people are suffering from chronic stress exposure and manifesting with stress related diseases. First world countries such as America (American Psychological Association, 2010) and the United Kingdom report high levels of stress (Health and Safety Executive, 2011). Stress seems to be poorly managed there as perceived stress levels in America have increased by 44% from 2005-2010. It was also found that the older generation and females are the most likely to experience high levels of stress since 2005 and there is an increase in perceived stress in 49% of their female population (American Psychological Association, 2010).

In western societies, work (85%), the economy and money were the greatest contributors to elevated stress levels (American Psychological Association, 2010). Stress will affect the economy and work environments because of absenteeism due to stress related diseases. As a result, 27 sick days were taken per person and 10.8 million working days were lost in Great Britain during the year 2010-2011. In the United Kingdom the estimated days taken off work were 5.9 million days for the period 2010-2011 (Health and Safety Executive, 2011). In America, there is an estimated $5000 loss per employee and a yearly loss of $400 billion due to
decreased productivity, health costs and absenteeism from stress, with no improvements from the year 2009 to the present (PRWEB, 2012).

In South Africa, most individuals regardless of age, gender, race and social class experience moderate to high level of stress (van Zyl & Pietersen, 1999). This may be due to the fact that South Africans are exposed to a unique variety of situations which bring about stress, even at an early age (Barbarin & Richter, 2001; Brook, Rubenstone, Zhang, Morojele & Brook, 2011; Seedat, Stein, Jackson, Heeringa, Williams & Myer, 2009; Williams, Gonzalez, Williams, Mohammed, Moomal & Stein, 2008). These experiences include: socioeconomic inequalities (Mayosi, Flisher, Lalloo, Sitas, Tollman & Bradshaw, 2009), violence (Ward, Flisher, Zissis, Muller & Lombard, 2001), social constructs (Hamad, Fernald, Karlin, & Zinman, 2008), economic repression (Hamad et al., 2008), crime (Kaminer, Grimsrud, Meyer, Stein & Williams, 2008), HIV transmission (Kalichman, Simbayi, Kagee, Toefy, Jooste, Cain & Cherry, 2006), affirmative action (Coopmans, 2007), partner- and domestic abuse (Seedat et al., 2009).

In working environments, South Africans are more stressed than in other countries, with the greatest prevalence of stress in whites, females and a younger population (20-30 years old) (Coopmans, 2007). In the South African population, 35% of the black population, 34.7% of the coloured population and 38.1% of the white population experience high levels of stress (van Zyl, 2002: 26). The high levels of stress then increase the prevalence of chronic diseases such as hypertension and cardiovascular pathology, which in turn increase mortality rates, health costs and economic burdens on the South African economy (Steyn, 2007). Annually there can be as much as a R12 billion rand loss in South Africa due to stress related absenteeism and low work productivity (Lilford, 2010). These are huge losses in economic profits as well as in economic growth, and these effects can be prevented as stress is the number one modifiable risk factor (PRWEB, 2012).

1.3 Behavioural impact of stress and individual consequences

The majority of people with high levels of stress engage in poor behavioural patterns, which increase the occurrence of disease and decreases productivity. These behaviours include overeating, increased consumption of junk food, skipping meals and lack of physical activity (American Psychological Association, 2010). Females also report that increased eating and decreased physical activity is a coping strategy and this may be why they are more likely to experience exaggerated emotional and physical symptoms. Conversely, men participate more in
physical activity to manage stress and it may be the reason why men experience less stress. Men feel that exercise provides a physical outlet and prevents them from falling ill (American Psychological Association, 2010).

In South Africa, there is an increase in poor coping behaviours such as increased alcohol consumption, smoking and drug abuse, because of an inability to cope with psychological distress (Brook et al., 2011). Increased prevalence of dysfunctional relationships, drug and alcohol abuse are all signs of high stress levels and poor coping (van Zyl, 2002). In conjunction with the poor behavioural patterns, 48% of women and 62% of men, and 42% of girls and 33% of boys under the age of 15 were sedentary (Steyn, 2007). Urban South Africans were also found to have poor exercise habits (low physical activity), especially in the black population (Walker, 1995; Walker, Adam & Walker, 2001).

A lack of physical activity and a sedentary lifestyle increases stress (Glei et al., 2007; Steyn, 2007). The combination of stress and lack of physical activity causes a cocktail of disease manifestation, dysregulation and ineffective coping (Casaburi, Porszasz, Burns, Carithers, Chang & Cooper, 1997; Fentem, 1994). These diseases include chronic disease, heart disease and obesity. These are increasing rapidly in the South African population (van Zyl, 2002; Walker, 1995; Walker et al., 2001; Westaway, 2010). Since inactivity is a modifiable risk factor, it is of the utmost importance that professionals in the health care sector pay special attention to chronic stress related disease and its prevention, because better management of stress and its manifestations may be beneficent in a preventative manner (van Zyl, 2002; Westaway, Seager, van Zyl & Oosthuizen, 2003).

1.4 Management of stress

In order to manage stress and decrease the prevalence of stress related chronic diseases, there needs to be a physical coping mechanism. This coping mechanism must aim to decrease the activation of the stress response, reverse a chronic physical manifestation into a temporary one and allow adaptation. This is achieved, amongst other things, by means of physical exercise (Buckworth & Dishman, 2002; Cox, 2002; Kraus & Raab, 1961; Lovallo, 2005), such as aerobic exercise - a widely used modality for this problem (Bond, Lyle, Tappe, Seehafer & D’Zurilla, 2002; Buckworth & Dishman, 2002; Cox, 2002; Weinburg & Gould, 2007). This approach, however, is not inevitably effective in decreasing stress (Hansen, Stevens, & Richard, 2001; Hughes, 1984; Salmon, 2001).
Other modalities, such as those which fall under mind-body work therapies, have been found to be successful in the decrease of perceived stress (Bertisch, Wee, Phillips & McCarthy, 2009; Carlson, Speca, Faris & Patel, 2007; Carson, Carson, Gil & Baucom, 2004; Dobkin, & Zhao, 2011; Dutton, Bermudez, Matás, Majid & Myers, 2013; Holzel, Carmody, Vangel, Congleton, Yerramsetti, Gard & Lazar, 2011; Kang, Choi & Ryu, 2009; Keng, Smoski & Robins, 2011; Mackenzie, Carlson & Speca, 2005; Ott, Norris & Bauer-Wu, 2006; Stanley, Schaldach, Kiyonaga & Jha, 2011; Vollestad, Sivertsen, & Nielsen, 2011; Weinstein, Brown & Ryan, 2009). These include mindfulness/somatic awareness techniques like Yoga (Berger & Owen, 1988; Bertisch et al., 2009), Qi Jong (Bertisch et al., 2009; Bond et al, 2002; Cox, 2002; Quick, Quick, Nelson & Hurrell, 1997), body work (Feldenkrais, 1972; Hanna, 1993; Kerr, Kotynia & Kolt, 2002; Kolt & McConville, 2000) and Tai Chi (Bertisch et al., 2009; Tsai Wang, Chan, Lin, Wang, Tomlinson, Hsieh, Yang & Liu, 2003; Wang, Zhang, Rasmussen, Lin, Dunning, Kang, Park & Lo, 2009).

Mindfulness and somatic awareness are techniques which are comparable in theory and in practice. One may even go as far as saying that the concept of “mindfulness is synonymous with awareness” (Miller, Fletcher & Kabat-Zinn, 1995: 193). Mindfulness and somatic awareness techniques both implement and aim to develop improved breathing, bodily awareness, attention to the self, embodied presence, postural stability and quality of movement (Alexander, 1985; Feldenkrais, 1972; Hanna, 1993; Hannon, 2006; Myers, 1998; Skjaerven, Gard & Kristoffersen, 2003; White, 2012).

Somatic awareness techniques or mind body therapies have been found to be effective in decreasing the manifestations of stress, because they encompass the psychological and physiological components of the individual, and holistically integrate the self (Hanna, 1993). This is achieved by teaching correct movement patterns (Hanna, 1993), and by increasing one’s awareness of the acute and chronic physical manifestations of poor and correct movement patterns. This is a new and exciting way forward, because one may approach psychological stress from a movement (physical) perspective by integrating somatic awareness exercise into the biopsychosocial model (Myers, 1998).
1.5 Problem statement and purpose of the study

There is a need for improved stress coping techniques because stress is poorly managed (American Psychological Association, 2010) and stress is a modifiable risk factor (PRWEB, 2012). The increase in sedentary lifestyle in the South African population is also a modifiable risk factor, but the use of aerobic exercise as a coping mechanism has limited value in decreasing stress (Hansen et al., 2001; Hughes, 1984; Salmon, 2001). If one can decrease the chronic physical manifestations of the stress response by other means, such as through somatic awareness, one can help decrease the prevalence of chronic stress related diseases, mortality rates as well as decreasing the economic burdens of stress. Since mindfulness techniques are successful in decreasing stress, the main purpose of the study was to determine the efficacy of somatic awareness exercise on the chronic physical manifestations of the stress response and compare it to findings with what happens to the stress response of participants subjected to a physical exercise (aerobic exercise) programme. In addition to these two modalities, the study will also investigate the combination of these in trained and untrained individuals.

1.6 Aims of the present study

- The primary aim of the study was to compare from a Biokinetic perspective, the efficacy of two physical intervention protocols on the perception of stress and the physiological response to stress in individuals identified with chronic stress. One of the physical intervention protocols being an aerobic physical exercise programme and the other a sensory awareness exercise programme.
- The second aim of this study was to investigate the benefits of combining aerobic and somatic awareness exercise on the response to stress and the perception of stress.
- The third aim was to determine the effect of somatic awareness exercise on perceived stress and its chronic physical manifestations in individuals already involved in physical exercise training, and to compare these findings with those found in untrained individuals.
- The fourth aim was to determine which modality of exercise and which combination of exercise would yield the best results. In other words, to determine which modality would be most successful in decreased subjective stress and its associated chronic physical manifestations.
- The fifth aim of the study was to write up a thorough literature study on chronic stress and its physiological and psychological consequences.
• The sixth aim was to introduce to the field of Biokinetics the concepts of somatic awareness, bodywork and their effects on chronic stress and its ramifications by means of a literature study.

These aims led to the development of the research hypothesis.

1.7 Research hypotheses

The research hypotheses are:

Somatic awareness exercise will be successful in decreasing perceived stress and the chronic physical manifestations of the stress response in untrained moderately to highly stressed individuals.

Participation in somatic awareness exercise will decrease stress more than participation in aerobic exercise in moderately to highly stressed individuals.

The combination of somatic awareness exercise and aerobic exercise in untrained individuals will decrease perceived stress and the chronic physical ramifications of stress more than the somatic awareness exercise in moderately to highly stressed individuals.

The combination of somatic awareness exercise and aerobic exercise will reduce the chronic physical manifestations and perceived stress levels more in stressed untrained individuals than in stressed trained individuals.

Aerobic physical exercise will be more effective than no exercise, in reducing perceived stress and the chronic physical symptoms in stressed individuals.

Thus, the final hypothesis is:

All modalities will be successful in reducing the chronic physical manifestations of the stress response. The most successful modality in decreasing stress will be the combination of somatic awareness and aerobic exercise, and the least successful the aerobic exercise.
1.8 Delimitations

The present research found it necessary to implement the following delimitations within the study:

- The volunteers were selected from the Johannesburg area in the Gauteng province of the Republic of South Africa,
- The volunteers were aged 18-65,
- Volunteers who did not adhere to the prescribed methodology and protocols for the duration of the study were excluded from the study, this included those that did not complete the post-test,
- All the volunteers within the study met the following inclusion criteria: 1) no participation in regular exercise six months prior to the study, 2) free from illness and relative- and absolute medical conditions prohibiting participation in an exercise programme and 3) a stress score greater than 10.
- An intervention (non-exercising) control group was also instituted in order to account for the transference of learning in the post-test which could have arisen when the subjects were allowed to become accustomed to the equipment and testing protocol.

1.9 Limitations

In the present study there are several limitations, the principle limitation is the small sample size in each group and the irregularity of numbers in each group due to volunteer exclusion. As a result of the small sample size, there is an increased type II error where it is difficult to identify relationships between groups, therefore no comparison was made between males and females, different age groups or race. As a result of this, the research may lack in statistical power and large numbers of analysis. The present investigation only made use of one-day pre- and post-test subjective and objective stress testing and not continuous testing throughout the eight weeks.

Due to certain lifestyle factors which were not accounted for such as: perception to exercise, hormonal fluctuations, marital status, nutrition, social and work environments, stressful life experience, caffeine, alcohol and nicotine intake, the current investigation encountered limitations, which could have impacted on a person’s stress levels and the severity of stress perception (Selye, 1976). Such interventions were not forthcoming since the present investigation attempted to determine only the effects of the exercise interventions alone.
In conclusion, the South African population is developing poor coping behaviours because of the elevated levels of stress. As a result of poor lifestyle behaviours and the exposure to stress there is an increase in stress related chronic disease. This emphasises the need for a physical coping mechanism, and an imperativeness to identify various preventative and management strategies in dealing with stress. As such the following chapter presents the history of stress, incidence, prevalence and morbidity stress related chronic physical manifestations. The physiology of stress and chronic stress will be examined, effectively highlighting the importance of stress and its management. As identified in the present and following chapters the need to identify the manifestations and stress related factors is of critical importance since these factors are needed to define and delimit the scope of the study. Additionally, the following chapter will further present the lack of data on somatic awareness exercise’s effects on stress parameters further confirming the need to implement an effective stress coping programme from a biokinetic perspective for the management and coping of the chronic physical manifestations of the stress response.
“Stress, in addition to being itself, was also the cause of itself and the result of itself” (Rosch, 1986: ix).

“...the concept of stress is an abstraction; but so is life, which could hardly be rejected as irrelevant to the study of biology. No one has studied life in a pure, uncontaminated form. It is always inseparably attached to something else which is more tangible and seemingly more real, such as the body of a cat, a dog, or a man; still, the whole science of physiology is built upon this abstraction” (Selye, 1978: 49).

The phenomenon known as stress, or the stress response, is an all-encompassing term for responses and processes which are associated with adaptations to a changing, demanding and challenging environment (Matthews, 2000). This is a broad definition of what may be called a stressor. Stressors could include anything that might elicit some sort of stress response (Pacak & McCarthy, 2000).

Selye (1936, 1974, 1976, 1978) defined stress as the non-specific response of the body to any demand. It is the sum of all strains, wear and tear caused by living (Selye, 1978). In the daily life of an individual, stress plays a significant role and it is a normal, natural and unavoidable occurrence. Stress initiates constant changes, forces bodily adaptations and constantly challenges the body’s homeostasis. Homeostasis is the ability of a system to return to its resting state once there has been a disturbance in the system. Stress, therefore can be seen as an unbalancing of the homeostasis of an individual (Chrousos, Loriaux & Gold, 1988; Everly, 1989; Everly & Lating, 2002; Lovallo, 2005; Powers & Howley, 2007; Selye, 1974, 1976, 1978, 1982). By merging the concept of homeostasis to Selye’s definition of the stress response, a normal response to a stressor is an attempt to maintain homeostasis. The discovery of the stress phenomenon and related topics will be discussed in Section 2.1.
2.1 An historic perspective on stress

Stress may seem to be a new concept, but it is a very old phenomenon. From approximately 500 BC to 1689 AD, philosophers such as Hippocrates considered the body to be a balanced system (Garrison, 1966). Anything that disrupted this balance chronically, whether it was physical or emotional, would result in disease. The presence of disease was identified with symptoms and signs which arose from the biological system of each individual (Everly & Lating, 2002).

The importance of the internal balance of each individual was further emphasised by Claude Bernard (1813-1878), a French physiologist (Gross, 1988). He was the first to emphasise the importance of the internal environment of the organism, which he referred to as the \textit{milieu interne} (the fluid matrix surrounding each cell in the body). In this matrix the living elements of the body interact in the body’s circulating fluids. These fluids consist of water, inorganic salts, oxygen, carbon dioxide, secretions from the various glands, acids and alkali, substances and plasma proteins (Gross, 1988).

An American physiologist, Walter Cannon (1871-1945) (Brooks, Koizumi & Pinkston, 1972), later built onto this the concept of a stable interior environment. He emphasised that stability could only be achieved by mutual integration of control- and regulatory processes, since stability required continual exchange of chemical substances between extra- and intracellular compartments, as well as between the internal and external environment of the organism. He proposed the term, homeostasis, to describe this stable state. The homeostatic system is a full body occurrence, which is used to maintain a variety of conditions, ranging from temperature, blood glucose, oxygen, etc. It is an open system which interacts with the external environment, while constant catabolism and anabolism occur within the cells (Cannon, 1967).

Stress disrupts the process of homeostasis, but the body is nevertheless able to adapt to this situation, thus maintaining a steady state. The ability to adapt to stress and the phenomenon of stress itself was first described by Selye (1936) who began to unravel the phenomenon known as stress (Selye, 1936, 1974, 1976, 1982). With this discovery Selye became known as the Father of the Stress Concept (Everly & Lating, 2002).

The research on stress began in the medical school where Selye worked. He observed that many individuals presented with similar symptoms despite suffering from different diseases (Selye, 1974, 1978), or with what could be named “the sick syndrome.” Symptoms such as adrenal
cortex enlargement, lymphatic structure shrinkage and ulceration of the stomach lining, were found. He also noticed that these symptoms characterised the presence of disease, but not of any one particular disease (Selye, 1978). By means of further experimentation he discovered that he could produce the same syndrome symptoms with any agent and that there was a “stereotyped response to damage” (Selye, 1978: 35). On July 4 1936, the British Journal of Nature published a paper, “A Syndrome produced by Diverse Nocuous Agents”. In this paper, Selye (1936) introduced the concept of the “General Adaptation Syndrome” (G.A.S.) which consists of three stages: the alarm reaction for the primary response that occurs; stage of resistance for the second phase; and then the final stage of exhaustion (Selye, 1936, 1978). After the publication of this paper in 1936, medical science altered its belief that various factors could cause various ailments with various symptoms, thereby widening the scope of medicine from purely reductionistic to a more open-minded and holistically integrated approach (Everly & Lating, 2002). These concepts will be discussed in more detail in Section 3.4.

2.2 Stress as a phenomenon

2.2.1 Definition of stress

“...stress is an abstraction and has no independent existence. We cannot cause stress without also producing some specific actions characteristic more particularly of the agent with which we produced it. What we actually see when something acts upon the living body is a combination of stress and the specific actions of the agent” (Selye, 1978: 53).

This quote from Selye (1978) demonstrates the abstractness of the stress response. The stress response differs from other biological responses in that the actual stress response is non-specifically elicited but has a specific form of reaction (Jarvis, 1999; Seaward, 2006; Selye, 1978). However, it must be noted that a single change will not elicit a stress response. In order to bring about a stress response there needs to be a cumulative change. Therefore stress is described as a sum of changes and manifests as a syndrome (Jarvis, 1999; Seaward, 2006; Selye, 1978). Although localised stress which occurs at a specific area may implicate a single organ and the change may only be in that specific tissue, the general stress syndrome is constituted of various changes over the entire body in response to a stressor (Selye, 1978). Thus general systemic stress is the total of all the non-specific effects of the body’s reactions; in other words, it is a whole response, which represents the sum of all the stress response reactions throughout the bodily systems (Selye, 1974, 1976, 1978).
2.2.2 Types of stress

Stress can be classified into three different types, namely “nustress”, “eustress” and “distress” (Seaward, 2006). Each will be briefly discussed below. Whether a stressor will be deemed as “eustress” or “distress” is dependent on the perception (See Figure 2.1), experience and learning of the individual (Lugar, Deuster, Gold, Loriaux & Chrousos, 1988).

2.2.2.1 Nustress

Nustress is the most natural and neutral form of stress. It is necessary for executing daily physical functions (breathing) or activities of daily living (ADL) (walking) (Courtney, 2009; Morse & Furst, 1979). Gallwey (1975) described this type of stress as an objective state, where neither subjective interference of emotion nor judgment is present, only the objective neutral state. It represents a feeling of indifference and tolerance (Gallwey, 1975; Seaward, 2006; Selye, 1974).

2.2.2.2 Eustress

Eustress is understood to be a favourable kind of stress with a positive perception that is comprised of active coping as well as striving to gain and maintain control, e.g. participating in an exercise regimen (Seaward, 2006; Selye, 1976, 1978). It is a positive, healthy stress that can be seen as physiological arousal, a source of psychic energy and an increase in both mental and physical performance (See Figure 2.1). Even though eustress is the “good” kind of stress, and causes less damage than distress, it is still stress and cannot be chronically maintained. In order to prevent stress levels from becoming excessive, rest would eventually be needed (Selye, 1976, 1978).

2.2.2.3 Distress

Distress is derived from Hans Selye’s General Adaptation Syndrome (Section 2.2.3.5). It is perceived as the negative counterpart of stress and is an inability to adapt to internal strain (Seaward, 2006; Selye, 1982). Since it is stress that is non-specific, the body will react with the same specific reaction to various types of negative stimuli (Selye, 1974, 1978). Distress differs from eustress by presenting with general and developed psychological (cognitive and somatic anxiety) (Matthews, 2000) and physiological (muscle tension and decreased fluidity of
movement) (Gallwey, 1975) stress responses that occur due to noxious and intimidating life trials (see Figure 2.1).

![Diagram](image.png)

**Figure 2.1:** Differentiation between eustress and distress (van Niekerk, 2010, personal communication)

### 2.2.3 The stress continuum

The various types of stress can be categorised into different stress continuums, and these continuums explain how stress plays a large role in performance, energy levels, experience and the manner in which an individual experiences life on a daily basis. These types of stress may be linked to Selye’s experience continuum (Selye, 1974) (Section 2.2.3.1, Figure 2.2), the Inverted-U Hypothesis (Section 2.2.3.2) and the Human Performance Curve (Patel, 1991) (Section 2.2.3.2, Figure 2.3).

#### 2.2.3.1 Selye’s experience continuum

Selye is the father of the stress concept, and he also has his own continuum to explain the phenomenon and how one can experience both eustress and distress. Stress can be associated with unpleasant or even pleasant experiences. In Figure 2.2, the relationship between stress and various life experiences is shown (Selye, 1974). It differs from the original by the labels: “Extremely Unpleasant” is replaced by “stimulus deprivation” since not every under-stimulating stimulus will be unpleasant and “Extremely Pleasant” is replaced by “over stimulated” or “excess” since not every excessive stimulus will be experienced as being pleasant. When there is psychological indifference or nustress the physiological stress level is at its lowest, while pleasant as well as unpleasant emotional arousal is accompanied by an increase in physiological stress. This increase need not lead to distress (Selye, 1974).
According to the theoretical model shown in Figure 2.2, an excessive increase or decrease (deprivation) in stimuli can cause the levels of stress to increase to such an extent that distress occurs. In Figure 2.2, it can be seen that a minimum level of stress can be experienced, if the level of stress is below this point then there is lack of sufficient stimulation and this is associated with a reduction in living expectancy and eventually death (Selye, 1974, 1976). So, in order for life to be sustained and lived fully there needs to be an optimum level of stress where we can function and perform efficiently.

![Figure 2.2: Theoretical model showing the relation between stress and various life experiences (Selye, 1974: 33)](image)

### 2.2.3.2 The Inverted-U Hypothesis and the human performance

The Inverted-U Hypothesis (Baechle & Earle, 2000; Cox, 2002; Gandee, Knierim & Mclittle-Marino, 1998) and the Human Performance Curve (Figure 2.3) explain how stress affects human performance and one’s ability to perform (Patel, 1991; Seaward, 2006). The hypothesis explains how various levels of stress and arousal may affect performance. If there is minimal arousal, there is insufficient stress to maintain the stimulation of an individual and performance is
decreased (Cox, 2002; Patel, 1991; Seaward, 2006). Too little stress, termed as deprivation stress, presents with minimal challenges where no personal growth is achieved, skills are underutilised, boredom is experienced along with a feeling of lack of meaning and purpose. In other words, there is stimulus deprivation with the result that human performance is hindered (Figure 2.3) (Patel, 1991; Seaward, 2006). This can be termed “deprivation stress” (Galdston, 1954; Selye, 1974, 1976, 1978). It is said that individuals under minimum stress levels, experience an intense craving for external sensory stimulation, bodily movements and motion (Selye, 1978). Inferring that even though there is little stress it can still be interpreted as a negative perception in the stress continuum (Figure 2.2).

On the other side of the continuum if there is adequate stress, or eustress, then the individual is at an optimum level of stimulation. His/her performance will be optimal and the work efficiency will be elevated (Baechle & Earle, 2000; Cox, 2002), balance is achieved and there is a greater sense of achievement (Cox, 2002; Patel, 1991; Selye, 1974, 1978). The apex of optimum level for production and performance varies amongst individuals and is dependent on genetics, physiology and behavioural factors (Everly, 1989; Everly & Lating, 2002). This level of stimulation is important because the normal functioning of the brain depends on continuous sensory input to arouse the reticular formation (Selye, 1978). The reticular-activating hypofrontality model integrates the use of exercise in activating the arousal mechanism of the reticular activating mechanisms and in disengaging the prefrontal cortex’s higher functions. This process is necessary to prevent the emotional processes from interfering with the motor functions (Dietrich & Audriffen, 2011). This level of stress is seen as intense but represents a relaxed concentration, where one is able to be aware of bodily rhythm, motion and thoughts (Feldenkrais, 1972; Gallwey, 1975). This is known as an exercise induced state of consciousness (Section 3.4.6), where introspection, and timelessness attention are experienced (Dietrich & Audriffen, 2011). However, this concentration level should be balanced with optimal levels of stress. If there is an excessive level of aspiration or too much emphasis placed on the system, then internal tension results, as it would in distress (Feldenkrais, 1972; Gallwey, 1975).

In Figure 2.3, the top of the curve indicates the level of optimal performance. It can be seen that on either side of this peak, performance drops with excessive or insufficient levels of stress. Fatigue begins to set in when there are excessively high levels of stress and if the individual experiences too much stress then distress may ensue. This is when there are greater demands placed on the individual than he/she can handle. There is a constant load of work, with mental, emotional and physical exhaustion and constant overdrive. When the chronic elevated levels of
stress are maintained and a breakdown occurs, chronic neurotic tendencies or psychosomatic illnesses and burnout may develop, with a severe exponential decline in performance and efficiency as well as physical, mental and emotional well-being. This can be seen in Figure 2.3 on the right hand side of the curve (Lugar et al. 1988; Lundberg, 2000; Patel, 1991; Selye, 1974, 1976, 1978). A relevant example of how excessive stress or allostatic load (Section 2.2.3.3) may cause damage is by engaging in excessive levels of physical activity. This is known as overtraining (Section 2.3.6.4.5). There is a shift to the right side of the performance curve causing burn out (Lovallo, 2005). In order to prevent and revert back to optimal level one needs to rest and recover by decreasing the physical activity levels accordingly. This will cause a shift back to left where the optimal stress levels lie. The importance of this concept ties in the fact that the two diagrams (Figure 2.2 and Figure 2.3) are the inverse of each other. If one brings the stress level back to an optimum level then the hindered performance levels may be reversed and adapted to suit each individual and/or situation.

![Human Performance Curve](image.png)

**Figure 2.3:** The Human Performance Curve (Patel, 1991: 12)
As humans grow and develop, they adapt to the stresses of life. Unfortunately, many assume that high levels of stress are an integral part of a normal lifestyle and they continue to live in states of high stress (Pacak & McCarthy, 2000). Since the general population is in a state of overstimulation (Figure 2.2), if one was not to return to the optimal levels of stress there can occur maladaptation so severe that it may result in disease. Many diseases are not from direct affects or causes, but rather from maladaptation of the physiological systems in response to stress (Selye, 1974, 1976, 1978). Diseases caused by this are termed “diseases of adaptation” (Section 2.3.6.2) and may be related to many nervous and emotional disturbances (Selye, 1974, 1978). Therefore one’s objective would be to bring the stress experience back to the apex of the curve and towards the optimal stress level by use of coping mechanisms (Section 2.3.6) and the body’s ability to adapt dynamically.

2.2.3.3 Allostasis

The ability to adjust dynamically to life’s stress is an important adaptation. McEwen and Lasley (2002) have built on Selye’s concept, and in place of homeostasis, they proposed the concept of allostasis, which is the ability of a system to dynamically adjust by changing various variables in order to adapt to changing environments. Chrousos (2009) defines allostasis as cacostasis, which is a defective homeostasis which may be harmful to the organism during acute and chronic experiences if no adaptation occurs.

Allostasis is an advanced concept, as the concept of homeostasis refers to returning the system to a resting state. Allostasis, on the other hand, refers to the system acting as a dynamic unit and being able to coordinate a variety of actions in order to adapt to a new environment. Thereby the system has an increased adaptability and flexibility to respond and an increased responsiveness to a magnitude of environments and stimuli (Sapolsky, 2004). This approach or idea fits into the General Systems Theory (GST) or “systems philosophy” (Laszlo, 1972, 2007; von Bertalanffy, 1955, 1968).

General systems theory considers the world in terms of the “interrelatedness and interdependence of all phenomena”, and within this framework defines a system as a set of objects together with the relationships between the objects and between their attributes (Capra, 1985; Hall & Fagen, 1968; Hazzard, 1971). All the parts together make up a whole, and it is the whole that determines the function of the parts (Bischof, 2002; Rose, 1997).
“Ordo ab Chao” (Latin Masonry Quote of the 33rd degree meaning “order out of chaos”; Mackey, 1917: 537).

In order to create order from chaos there must be the togetherness of the parts and their ability to organise their functions. Of equal importance as the functioning of the whole, the organisation of the parts determines the functionality of the whole. In the present case the whole represents the biological system and the various parts are the stress reactions (Laszlo, 1972). Due to the phenomenon of self-organisation, which is a central tenet of the General Systems Theory, the various parts organise and stabilise themselves (or undergo allostasis). This allows the whole to evolve (Laszlo, 1972). The adapted system is resistant to the forcings or stressors, which initiate the process of self-organisation. The reason for this is that the self-organisation, which occurs drastically changes the systems structure (Laszlo, 1972). For order to occur, and to allow allostasis to be effective, dynamic energy is needed (Korte, Koolhaas, Wingfield & McEwen, 2005; Pardon, 2007; Romero, Dickens & Cyr, 2009).

2.2.3.4 Adaptive energy

“The mind itself ‘endelecheia’, ···a certain continual, eternal motion” (Bennett & Hacker, 2002: 5).

There are two kinds of adaptive energy: deeper and superficial. The superficial energy is usually depleted after exertion and is replenished with rest from the deeper storage. The reason for the use of only the superficial energy is that it increases the flexibility to change for the organism and protects the organism from depleting all the reserves on a single activity. This in turn forces the organism to create change by utilising other mechanisms and tissues. Selye (1978) defined this event as an “equaliser” of activities. An equaliser is a distraction from an activity that can neutralise or distribute the amount of stress across the organism. The relevance of this is preventing one area from becoming chronically exposed and affected by the stress response, thereby equalising the stress response on the specific target area. The constant shift from one activity to another evens out the “wear and tear” (Selye, 1978) and increases the ability of the organism to adapt. Adaptation will be discussed further in Section 2.3.6.1. Behavioural factors such as participation in exercise may act as an equaliser and increase the apex of the curve (Figure 2.3) and brings one to the level of “Optimal Stress” (Patel, 1991) and towards psychological and physiological competence (Brooks, Fahey & Baldwin, 2005). The importance of this statement lies in the fact that not only does physical exercise return an individual to a
level of optimal stress, but it can also increase the resilience to stress and prolong the period of an “optimal stress” level (Buckworth & Dishman, 2002). This ability to increase one’s resilience to stress is achieved through allostasis and the use of adaptive energy, thereby decreasing the likelihood of entering into the “Too Much Stress” level (Figure 2.3) and preventing the negative manifestations of stress that may occur. The use of exercise as an equaliser for stress will be discussed in Section 2.3.6.4. The ability of the body to adapt will be discussed in the following section.

2.2.3.5 The General Adaptation Syndrome

Selye (1936, 1967, 1974, 1976, 1978, 1982) elucidated mainly one of the adaptation syndromes, (a) the General Adaptation Syndrome (G.A.S.). However, according to Mikhail (1985: 34), the G.A.S. could be more accurately described as a theory of adaptation to stress rather than a stress theory.

The G.A.S. is made up of three stages: An alarm phase; a resistance phase; and an exhaustion phase (Selye, 1936, 1974, 1976, 1978). Seen from a systems theory perspective (Laszlo, 1972) the three stages of the G.A.S. make up a stress response system. The functioning of the parts contributes to the functioning of the system; if one part should be missing in Figure 2.4, then the function of the whole system would be compromised.

The alarm phase is an acute phase where the level of normal resistance decreases (Selye, 1974, 1978) due to exposure to a stressor. The adjustment made during the alarm reaction is used to gain resistance to the agent causing stress (Muthayya, 2002; Selye, 1974, 1978). The stress response then occurs which is a generalised somatic shock (Everly, 1989; Everly & Lating, 2002; Selye, 1974, 1976, 1978). In the alarm phase there are two reactions which occur: the initial passive shock to the stressor followed by the attempts of defence to counter the shock (Muthayya, 2002). The physiology of this will be discussed in Section 2.3.4.1. If an organism cannot make a shift from the alarm stage into the next stage - i.e. if the alarm stage is sufficiently strong, cacostasis ensues and eventually it dies (Selye, 1974, 1978).

The second stage of resistance occurs when the body attempts to shift from the alarm phase to a higher level of allostasis or hyperstasis. In other words, the level of resistance rises above the normal level. The resistance phase is when the stressor application is continuous and there is a constant demand placed on the body. The resistance reactions which occur usually oppose and
counteract the alarm phase. Due to these reactions, the flight or fight response is now less effective (Eysenck, 2002). Adaptation is acquired in this phase (Muthayya, 2002; Selye, 1974, 1978), and there are two types, namely developmental and redevelopmental (see Section 2.3.6.1).

Figure 2.4: The three phases of the General Adaptation Syndrome (Luckmann & Sorensen, 1974; Selye, 1936, 1974, 1976, 1978). The levels of resistance are shown on the Y-axis while the 3 stages of adaptation are shown on the X-axis.

The third and final phase is that of exhaustion. The resistance phase cannot be maintained for an indefinite period and any adaptation that has taken place is now lost. The reactions that occur are similar to the alarm phase (Muthayya, 2002; Selye, 1974), the adrenals are activated and there are increases in the corticoid levels above the maximum levels reached during the alarm phase (Selye, 1978). Stress-related disease occurs where there is enlargement of the adrenal cortex which may later become necrotic, the immune organs (thymus and spleen) shrink and bleed, and the stomach haemorrhages due to ulcers (Eysenck, 2002; McEwen & Lasley, 2002; Patel, 1991; Selye, 1974). Unless the stressor is removed, the organism dies (Muthayya, 2002) (Section 2.3.6.2).
2.2.3.6 Functional purpose of stress

As has been mentioned stress is an integrated part of daily living and sufficient amounts of stress have to be experienced in order to function, adapt and survive (Everly, 1989; Everly & Lating, 2002; Selye, 1974, 1978) (Section 2.2.3.2).

Systemic stress acts as an equaliser of reactions within each individual. It decreases the overexertion of each part; instead of localising the stress at a local place it spreads the stress systemically, thereby preventing each part from becoming overworked (Selye, 1974, 1976, 1978). In Figure 2.5, it can be seen that the relationship between physical and psychological stress permits the body to “spread” the stress across the system. This results in an equalising effect and forces the organism to use and develop skills and unmask potential that would otherwise not be used. It is only when an individual is placed under stress that these traits can surface (Selye, 1974, 1978). This can in turn mould the individual to the stress placed on him and his surroundings and the characteristics of each individual that manifest are as a result of the stresses placed on him/her throughout life (Selye, 1978). This is indicated in Figure 2.5 as heterostasis, a concept similar to that of allostasis. The only difference between the two is that allostasis, is seen as a conceptually broader term (Brooks et al., 1972; Cacioppo, Tassinary & Berntso, 2007; Woods & Ramsay, 2007).

Figure 2.5: A proposed model to demonstrate the relationship between physical and psychological stress (van Niekerk, 2010, personal communication)
The stress response in itself expends a lot of energy, it interferes with other adaptive changes and the changes that occur as a result may cause tissue damage. Therefore the stress response is only initiated when it is necessary (Nesse & Young, 2000). One of the main functions of the stress response is to prepare the body for the physical exertion required for survival (Everly, 1989; Everly & Lating, 2002). If the stress response was constantly activated and the stress was not equally distributed through the body, then Stage 3 of the G.A.S. could occur. However, for this reason, the body needs to be able to constantly adapt and to equalise the stress (Nesse & Young, 2000). This is achieved, amongst other things, by means of physical exercise, breathing techniques and movement; aspects which will be discussed in Section 2.3.6.4.

The main function of stress is therefore to prepare the body for physical exertion associated with the alarm phase of the G.A.S. to act as an equaliser and to cause adaptations necessary for survival in the resistance phase of the G.A.S. (Everly, 1989; Everly & Lating, 2002; Selye, 1974, 1976, 1978).

### 2.3 Models of stress

One specific recent model of stress is based upon the GST (Section 2.2.3.3.) and views the whole stress response as an interactive dynamic process with multidimensionality (Everly, 1989; Everly & Lating, 2002). The model is shown in Figure 2.6.

There are six steps in their systems stress model, outlined below:

1. Step 1: Stressor event;
2. Step 2: Cognitive appraisal and affective integration;
3. Step 3: Neurological triggering mechanisms;
4. Step 4: Stress response: efferent physiological mechanisms of mediation;
5. Step 5: Target organ activation; and
2.3.1 Step 1: Stressor event

2.3.1.1 Definition of a stressor

A stressor is an event which precedes the stress response and places a demand on the individual in either a physical, emotional or mental manner (Everly, 1989; Everly & Lating, 2009; Patel, 1991; Powers & Howley, 2007; Selye, 1974, 1978). It is change which disrupts homeostasis (Hendler, 1982; Pacak & McCarthy, 2000). The nature of the stressor and our perception of the stressor are important in eliciting the stress response. Therefore interacting with the environment and choosing whether or not to resist or disregard the stressor plays a crucial role in how that stressor will be interpreted (Selye, 1974). The interpretation of the stressor is discussed in Section 2.3.2.

The stressor initiates the stress response (its exact nature will be discussed in Section 2.3.4), which is non-specific and irrelevant to the type and nature of the stressor. As long as a stressor is present and the physiological mechanisms are activated the response elicited is the same. The body acts in the same physical manner by initiating the mechanisms of the stress response whether the stressor is mental, emotional or physical in nature (Everly & Lating, 2002; Selye, 1976).
2.3.1.2 Classification of stressors

Stressors may be classified in many ways; by origin: internal and external (Patel, 1991); by duration: acute and chronic; and by character: biogenic, social and psychosocial (Everly & Lating, 2002).

2.3.1.2.1 Origin of stressors: Internal and external

Internal stressors are those, which are integrated in the body and determine resistance from within each individual: these include genetics (Koch & Stratakis, 2000; Matthews, 2000; Patel, 1991; Selye, 1976) and past experiences in life. External factors are external to the body and can influence the response to a stressor, for example, environmental (e.g. climate), ecological, economic, social (e.g. criticism) food intake, the amount of stress one is subjected to and physical condition (e.g. the individual’s health status) (Matthews, 2000; Patel, 1991; Selye, 1976).

2.3.1.2.2 Duration of stressors: Acute and chronic

A stressor is sensed by the organism when there is a change in the environment. It can be harmful and it can manifest in an acute or chronic stress response (Ottenweller, 2000). This research will deal with the latter. An acute stressor is usually single, intermittent with a limited exposure and is often seen in the alarm reaction. A chronic stressor is of continuous exposure, which occurs for extended periods of time (more than a month) and is mainly present in the resistance phase and the exhaustion phase (Pacak & McCarthy, 2000) (see Section 2.2.3.5).

2.3.1.2.3 Character of the stressor

The character of the stressor indicates the nature of the stressor. Stressors can be classified into physical and psychological (Lovallo, 2005); and biogenic and psychosocial (Everly & Lating, 2002). A biogenic stressor is usually electrical or biochemical in nature and it initiates the stress response by overriding the cognitive mechanism involved in processing a stress response, thereby acting directly on the person, e.g. nicotine, caffeine, extreme cold or heat (Everly & Lating, 2002). Psychological stressors probably play a bigger role in today’s society than the physical stressors and since man is a cognitive creature, these stressors are seen as the most important (Lovallo, 2005; Selye, 1978). The stressor may be real or imaginary; examples
include bereavement, examination stress and job loss. A psychosocial stressor has a cognitive interpretation, this means that if the stimulus is interpreted as threatening, it is a stressor and there will be a stress response. If the stimulus is interpreted as non-threatening, then it will not be perceived as a stressor and there will be no stress response (Cooper & Watson, 1991; Everly, 1989; Everly & Lating, 2002; Lovallo, 2005).

2.3.2 Step 2: Cognitive appraisal and affective integration

The event which initiates a stress response is known as the stressor (Section 2.3.1), which leads its cognitive appraisal by the cognitive system (Figure 2.6). The “Allan Schore’s tripartite model of regulation” integrates the environmental sensory information and it is processed in a hierarchy of limbic and cortical areas (Carroll, 2005). The information converges along the amygdala, the cingulate and the orbitofrontal cortex. These three act as a representational system of the ability to learn from experience and to effectively integrate information (Carroll, 2005). Lazarus and Folkman’s (1984) Psychological Appraisal Model maintains that there are two appraisals needed in order to interact with the environment and generate emotions which can lead to bodily stress responses.

These are the primary and secondary appraisals. During the primary appraisal, it is important to know whether the event is relevant to the individual and if it is associated with any goals (Figure 2.7 Stage 1). Figure 2.7 demonstrates the cognitive point of view and the manner in which we interact with our environment (Lovallo, 2005; Weinberg and Gould, 2007). In the alarm phase, the affective integration occurs where the stressor is deemed as either non-threatening or threatening. Once something is determined as relevant (Figure 2.1), the stress response will be initiated; if there is no relevance, then no response will be elicited (Figure 2.7 Stage 2). However, if it is perceived as a threatening stimulus or as stress, it will then flow to the next step where the non-specific reaction of the stress response is initiated (Figure 2.7 Stage 3). The secondary appraisal which takes part in the resistance phase, is concerned with coping options and emotions associated with it (Figure 2.7 Stage 4) (Cox, 2002; Lazarus, 1991; Lovallo, 2005). The appraisals determine the intensity and the type of psychological reactions that will occur and this in turn effects the physiological reactions (Cox, 2002; Lovallo, 2005).
The individual will respond physiologically with a generalised stress reaction to a “good” stressor as well as a “bad” stressor (Figure 2.7 Stage 3). Consequently, the initiation of the stress response is dependent on the interpretation of the stressor and not necessarily the stressor itself (Mikhail, 1981). Therefore, eustress and distress will have the same physical response. What differs between the two is the perception there of (Hendler, 1982; Selye, 1978) (Figure 2.7 Stage 2), e.g. excitement of playing a sports match versus fear of falling down the stairs. In the brain, the amygdala receives the sensory information first where there is an express assessment of the stressor, this initiates a startle reflex which activates the sympathetic nervous system (SNS) (Allan Schore’s tripartite model of regulation: Carroll, 2005) (Figure 2.6 Step 2). This mental appraisal and interpretation then sets the physical reaction in motion by initiating the neurological triggering mechanisms.
The mechanisms that are well known are the flight or fight response. However, there are three reactions that can occur as a result of stressors as opposed to the basic flight or fight response: Repression, Dissociation and Integration. Repression is when the left cortex inhibits regulatory processing, which results in detached emotional and logical responses along with movements which are repetitive and linear causing limited and stiff muscle movements (Carroll, 2005). Dissociation occurs when the right cortex is overwhelmed resulting in feelings of hysteria and chaos, the body will lose control of muscle movements, become helpless and with a frozen back almost an exaggerated fright response (Schore, 2009). Integration is the synergistic merging of the left and right brain to merge creativity and logic to produce an integrated response based on experience (Carroll, 2005). This is the ultimate goal, to achieve an optimal integrated level of stress (Section 2.2.3) (Figure 2.2 and Figure 2.3), along with an integrated balanced systemic response (Gallway, 1975; Laszlo, 2007).

In order to have a systemic response, one needs feedback. In Figure 2.6 feedback loops I to VI are depicted by dashed arrows. The use of feedback loops is a facet of the interactive aspect of the General Systems Theory (Laszlo, 2007). Their purpose is to “feed back” information to the systems participating in the stress response. The feedback impulses from the somatic and visceral systems ascend the tracts of the dorsal column system and the anterolateral spinothalamic tracts of the spinal cord via sympathetic and somatic afferents to the hypothalamus (Muthayya, 2002). During the resistance phase, these systems decrease or increase their participation in elicitation of the stress response based on the information received (Everly, 1989; Everly & Lating, 2002). In the resistance phase of the G.A.S., the feedback loops I to VI in Figure 2.6 all feed back into Step 2: cognitive appraisal and affective integration which causes a behavioural change (Figure 2.7 Stage 4). If an individual is coping, then the feedback loop V feeds back to Step 2 (Figure 2.6), the resistance phase continues and adaptation occurs. This aspect will be discussed in more detail in the section on coping (Section 2.3.6.). If there is no coping, then feedback loop VI feeds back and the exhaustion phase occurs. This aspect will be discussed in more detail in the section on Diseases of Adaptation (Section 2.3.6.2).
2.3.3 Step 3: Neurological triggering mechanisms

In the commencement of the alarm phase the neurological triggering mechanisms “switch on” a variety of physiological responses in the body, which results in the actual stress response (see step 4). The anatomical structures involved here are the limbic system, the locus ceruleus, the hypothalamic efferent triggering mechanisms and the hippocampus, the anterior and posterior hypothalamic nuclei and the septal-hippocampal amygdaloid complex. The latter complex is the centre for visceral and somatic efferent discharges and this centre responds to emotions by increasing arousal. This gives rise to the stress response and appears to endogenously determine the neurological tone (Everly, 1989; Everly & Lating, 2002). The physiological response is then initiated (Section 2.3.4).

The feedback loop labelled I, in Figure 2.6 (Everly & Lating, 2002: 24), maintains the positive feedback loop of a “charged arousal system or ergotropic tuning, or physiological arousal.” This plays a role in the responsiveness of the mechanisms of arousal and the sympathetic nervous system. If there is constant activation of this feedback loop, such as would be seen in chronic stress, then there is chronic tone present. In the exhaustion phase, there is obviously constant activation causing chronic tone, and increase in the likelihood of developing psychophysiological disorders. This demonstrates how the body’s ability to maintain the neurological firing actually increases the interpretation and maintenance of the stressor (Blakenship, 2007; Everly, 1989; Everly & Lating, 2002).

After the activation of the neurological triggering mechanisms the stress response and the “Efferent Physiologic Mechanisms of Mediation” or target organ activation (Figure 2.6 Step 4 and Step 5) is initiated (Section 2.3.4) (Everly, 1989; Everly & Lating, 2002).

2.3.4 Step 4: Stress response: Efferent physiological mechanisms of mediation

2.3.4.1 Physiological mechanisms involved in the elicitation of the stress response

The physiology of the stress response will be looked at briefly. The stress response pathway is shown in Figure 2.8 (Martini, 2006; Patel, 1991).
In Figure 2.8, the cognitive appraisal and the affective interpretation are included (Section 2.3.2), the higher brain centres are associated with the appraisal of demands in relation to coping resources while the hypothalamus is associated with the emotional impact according to the final evaluation (Martini, 2006: 627; Patel, 1991: 21).

The three physiological systems which the body impinges upon in order to elicit the response are the neural, neuroendocrine and endocrine systems (Everly, 1989; Everly & Lating, 2002). Metabolic systems are also utilised and the changes which occur are neurochemical in nature (Pacak & McCarthy, 2000). The neural and neuro-endocrine reactions/responses occur in the alarm phase and the endocrine system is seen to have a larger role in the resistance and exhaustion phase.

The alarm phase constitutes the initial passive shock to the stressor and then follows the attempts of the defence to counter the shock (Muthayya, 2002). The shock phase is made up of bodily reactions such as: depressed activity of the nervous system, increased haemoconcentration, decreased blood pressure, decreased chlorides in the blood, decreased body temperature, increased capillary permeability, tissue breakdown and a decreased metabolism (Muthayya, 2002).

The body then reacts to this shock phase, by promoting a counter reaction as seen in Figure 2.8. The immediate-acting autonomic nervous system is activated, and the stimulus passes through the neocortical and limbic systems to be interpreted. Nerve impulses then travel down to the posterior hypothalamus leading to sympathetic activation; and the sympathetic efferents descend to the thoracic and lumbar regions of the spinal cord, to pass through the sympathetic ganglia (Everly, 1989; Everly & Lating, 2002). From here the nerves innervate the target organs such as the adrenal medulla (Muthayya, 2002) and specialised kidney cells (Martini, 2006: 627; Patel, 1991: 21). The adrenal medulla is responsible for the secretion of adrenaline and noradrenalin which increase blood flow to the musculoskeletal system, increase heart- and breathing rate and blood-clotting factors to prevent blood loss and there is a reduction in blood flow to the gastrointestinal system (Eysenck, 2002; Selye, 1976). The kidney cells are responsible for rennin secretion which increases angiotensin levels in the blood. This stimulates the adrenal cortex to secrete mineralocorticoids such as aldosterone, which results in an increase in the level of blood chlorides by altering the kidney filtration rate (Eysenck, 2002; Muthayya, 2002; Selye, 1978). The fight or flight response is now activated (Eysenck, 2002). Once the stressor is removed the alarm phase ends (Everly, 1989; Everly & Lating, 2002; Selye, 1974, 1976, 1978).
The slower reacting endocrine system takes part in the resistance phase. The hypothalamo-hypophyseal portal system secretes a peptide called corticotropin releasing factor (CRF) which targets the pituitary gland where adrenocorticotropic hormone (ACTH) is released (Muthayya, 2002; Selye, 1976). This in turn triggers the adrenal cortex to secrete glucocorticoids (Selye,
The glucocorticoids increase the amount of glucose present in the blood, increase available fats and increase blood flow rate (Eysenck, 2002).

The change which occurs is a package of behavioural, experiential and physiological changes rather than just a single change (Pacak & McCarthy, 2000) as proposed in the general systems theory (Laszlo, 2007) (Section 2.3.5).

### 2.3.5 Step 5: Target organ activation

Activation of target organs includes all the organs and tissues which are influenced by the stress response, such as the cardiovascular system, skeletal muscle system, skin, gastrointestinal system, immune system, and the brain. The target organs are also the areas where the signs and symptoms of excessive stress response are noted (Everly & Lating, 2002; Selye, 1978). These organs are affected either by increased activity, activation, inhibition or catabolism. The reaction which takes place is based on the individual’s genetic factors and “past experiences” mentioned in Section 2.3.1.2.1. Examples of a target organ manifestation of chronic stress would be the presence of chronic neck pain or where a limb is the target organ, this would be as a result of the physiological response of excessive muscular tension and constriction of the blood vessels (Hanna, 2004).

Stress affects health through the responses of the body (Ottenweller, 2000). The target organs undergo morphological changes due to the stress response and a “Pluricausal Disease” often results. “Pluricausal” signifies there are many factors which bring about the development and progression of the disease. This is what is seen in the stress manifestations (Chaitow & Pizzorno, 2008; Selye, 1974, 1976, 1978). Any arousal or stimulation of the stress response mechanisms that is excessive, chronic and heightened in amplitude (Figure 2.2 and Figure 2.3) will cause target organ disease or dysfunction due to excessive stimulation and over-functioning of the target organ. This can lead to structural and/or biochemical changes. Thus, if an emotional factor leads to a physical symptom then psychosomatic or psychophysiological disease may result (Everly, 1989; Everly & Lating, 2002; Sudakov, Yumatov & Tarakanov, 1996) (Figure 2.5).

An example of how emotions can manifest into physical symptoms is bereavement (Everly & Lating, 2002). When one grieves, there are three things which can occur. The first is a sensation of numbness due to shock, where there are feelings of unreality, body distance and lifelessness.
The second phase is despair; strong feelings of anger, sadness, love and pain in the physical body are present. The physical pains can be chest and stomach pains, throat tightness and restlessness (Patel, 1991). The third phase is detachment, where there are feelings of letting go, adjustment and coping (Patel, 1991; Selye, 1974).

Psychosomatic disease often occurs in conjunction with chronic stress, and chronic stress elicits chronic inflammation. “ Activation of the stress system leads to behavioural and physical adaptations. These adaptations are related to the physical adaptation that includes changes in cardiovascular function, intermediary metabolism, and modulation of the immune and inflammatory reaction” (Chrousos, 2000: 3) (Figure 2.7 Stage 3 and Stage 4). The presence of chronic inflammation due to the chronic stress response occurs because of the physiology of the stress response.

- It has been shown that eliciting the stress response activates the sympathetic nervous system and the hypothalamic pituitary axis (HPA). There is a feedback loop between these two and the immune system, thus the immune system is activated (Chrousos, 2000).
- The chronic presence of stress hormones decrease the lymphocyte count.
- Cytokines stimulate the endothelial and glial cells which secrete inflammatory mediators such as prostanoids and interleukins (Chrousos, 2000).
- Cytokines, specifically the pro-inflammatory cytokines, activate the HPA axis and the SNS in the same way as does the stress response. These particular cytokines cause nausea, anorexia, depression, social withdrawal, hyperalgesia, elevated basal metabolic rate, alterations in sleeping patterns (Chrousos, 2000).
- Cytokines activate hepatic and other tissue synthesis of cell-adhesion molecules, fibrinogen, plasminogen and C-reactive protein (Chrousos, 2000).
- The excessive release of glucocorticoids causes glucocorticoid resistance of the immune system and a heightened inflammatory and immune response in the target tissues which could lead to rheumatoid arthritis, acquired immunodeficiency syndrome (AIDS), osteoarthritis, Crohn’s disease, lupus erythematosus, multiple sclerosis, type-1 diabetes mellitus, immune thyroid disease, asthma, eczema, food allergies, hay fever and increased histamine production, allergic rhinitis and infections. Inflammation in the central nervous system (CNS) might lead to Alzheimer’s disease or schizophrenia (Chrousos, 2000).
The presence of chronic inflammation has been linked to and speculated to cause or drive a variety of diseases, such as:

- **Cancer**: chronic inflammation has been known to play a role as a tumour promoter at critical phases of the malignant progression. Many cancers grow at sites of chronic inflammation, immune cells found in chronic inflammation are also seen in cancers and the inhibition of inflammatory mediators decreased experimental cancers (Balkwill, Charles & Mantovani, 2005; Chrousos, 2000).

- **Atherosclerosis**: caused by chronic inflammation from repeated acute psychological stress, as well as from chronic psychological stress. The pathophysiology is derived from the activation of the sympathetic nervous system (Black & Garbutt, 2002; Libby, 2002; Libby, Ridker & Hansson, 2009).

- **Degenerative diseases of middle and old age**, such as: atherosclerosis, cancer, Alzheimer’s disease, Parkinson’s disease, osteo- and rheumatoid arthritis as well as amyotrophic lateral sclerosis (Balkwill et al., 2005; Libby et al., 2009; McGeer & McGeer, 2004).

The main target organs affected by stress in the human body, as far as the present study is concerned, are the muscular system and the cardiovascular system.

**2.3.5.1 The skeletal muscle system**

The musculoskeletal system is a primary point for fast activation during the stress response and during emotional arousal (Hanna, 2004). This section deals with striated- and cardiac muscle. Smooth muscle will be discussed in Section 2.3.5.2.

The muscular system is activated as soon as the alarm phase occurs, demonstrating that during emotional (e.g. anger) as well as physical stress, tension in the muscular system increases (Gandee et al., 1998; Hanna, 2004; Lundburg, 2000; Orne & Whitehouse, 2000). This tension is apparent in the muscles as a sustained muscular contraction (Everly, 1989; Everly & Lating, 2002; Goldstein, 1964; Lowen, 1975; Lundburg, 2000; Ohman, 2000; Orne & Whitehouse, 2000) and if prolonged activation occurs then neurohormonal changes result including increased membrane excitability and increased muscle fibre binding (Selye, 1975; Schmidt, Richey, Zvolensky & Maner, 2008; van der Kolk, 1994). The skeletal muscle may be stressed physically (e.g. manual labour, exercise), mentally (e.g. thought) or emotionally resulting in this neuromuscular tension.
The sensory motor system responds to stressors through specific muscular reactions, which Hanna (2000) termed as habits (Section 3.2.5). A habit here means the acquisition of a functional movement pattern, which is initiated whenever the stress response becomes activated (Jones, 1965). When these habits are constantly activated, for example, as in the resistance phase or the exhaustion phase, then chronic muscular contraction and tension becomes the new movement pattern or habit. With time the habits become unconscious and involuntary, and loss of awareness of certain muscle groups results with the possible addition of pain. This is known as sensory-motor amnesia (SMA), and it is a learned adaptive response by the nervous system, meaning that the response and its effects on the muscular system can be “unlearnt”. “Unlearnt” here means that one can override the older adaptive response and therefore learn a new movement pattern (Hanna, 2004) (Section 3.3.1).

SMA occurs when an individual is under so much stress that the sensory information travelling to the neocortex is bypassed. Thus the information never reaches the neocortex but remains at the first and second levels of the triune brain, where involuntary control of the muscles originates (Hanna, 2004). The ability to move and the movement patterns become more restrained, because stress increases the vestibulocochlear reflex and spinal reflex activities. This in turn decreases the working memory, which decreases the monitoring and correcting executed by the cognitive system (Higuchi, Imanaka & Hatayama, 2002).

The greater the amount of stress experienced, the greater the tonus of the muscle, increased stiffness, pain and the inability to move freely (Hanna, 2004; Reich, 1973). This issue is discussed in further detail in Section 2.3.6.4.4. Stressors that are psychological in nature might increase limb stiffness due to the co-contraction of the antagonist and agonist muscles. Emotional stressors often increase muscular tone as well as cause rigidity and tension in the striated muscle, bruxism, hyperkinesias, pain, cramps and gesticulation occur (Selye, 1976).

The nature of the relationship between the muscular system and the emotions allows muscle movement and muscular contractions to be an outlet for the emotions and personality (Hanna, 2004; Lowen, 1975; Reich, 1973; Selye, 1976). As a consequence of this, the skeletal muscle may protect the body by armouring the muscles against emotional experiences (Lowen, 1975; Reich, 2002); thus chronic stress may cause a prolonged armouring (Section 3.2.3). Prolonged armouring causes body fatigue which in turn causes stiff and limited movements, chronic pain, chronic fatigue, chronic shallow breathing (Courtney, 2009; Sharp, Goldberg, Druz & Danon, 1975; Tobin, Chadha, Jenouri, Brich, Gazeroğlu & Sackner, 1983; Wientjes, 1992), chronic high
blood pressure and a negative self-image (Reich, 1973; Selye, 1976). This reaction by the muscular system to the stress response increases the limbic excitation and the emotional arousal as illustrated by feedback loops II and III on Figure 2.6 (Everly, 1989; Everly & Lating, 2002). The muscular tensions can result in cervical, lumbar and shoulder pain because of muscle bracing (Everly, 1989; Everly & Lating, 2002; Lundberg, 2000; Selye, 1976). The muscle bracing may cause tension headaches and migraines due to the constant tension and contraction of the *frontalis* portion of the *occipitofrontalis* muscle (Patel, 1991). Movement reactions that occur are hyperkinesias (inability to keep still), jaw clenching, finger drumming and nervous walking (Selye, 1976). Breathing may also be impaired and restricted because of hypertonic breathing muscles, immobile diaphragm and rapid shallow breathes (Courtney, 2009; Gilbert, 1999a, 1999b; Homma & Masaoka, 2008; Reich, 2002; Sharp *et al.*, 1975; Tobin *et al.*, 1983; Wientjes, 1992).

### 2.3.5.1.1 Body sway

Body sway is an indication of postural control present in humans to maintain an upright stance. Body sway can be measured. The human upright stance is unstable because humans have a high centre of gravity and are vertically positioned in relation to gravity. The ability to maintain posture or be upright is dependent on muscle tone and continuous activation of the muscular system. Maintaining stability even against the force of gravity is an integrated neural challenge stemming from the CNS in order to be dynamically neutral (McGill, 2007). Neutral is where there is minimal joint load, optimal load transfer through weight bearing positions, balanced length and tension relationships and a “neutral zone” where there is limited stress (Panjabi, 1992; Wallden, 2009). Body sway is affected by age, pain, muscular fatigue, support surface, sensory input integration, mass distribution, external loading and compensatory movements (Rosker, Markovic & Sarabon, 2011).

However, body sway is also affected by stress and body sway may be utilised as a measure to determine the amount of physical stress one is experiencing and thus may also be used as a marker of changes in physical stress (Balaban & Thayer, 2001). Body sway is affected by the same input that affects the stress response (interoceptive, exteroceptive and proprioceptive input) and it is also affected by stress response pathways such as the noradrenergic, monoamine and the serotonergic pathways and mechanisms (Balaban & Thayer, 2001). This is possible because a relationship exists between autonomic functions, emotional responses, balance processes and stress manifestations (Balaban & Thayer, 2001). In other words, one’s emotional state and stress

2.3.5.2 Cardiovascular system

The cardiovascular system is a target because it is affected by the pituitary and adrenal responses (Selye, 1976). This results in allostatic load/stress (Allostatic load is the amount of wear and tear experienced by the body in order to undergo allostasis) on the smooth muscle tissue which causes additional energy usage and excessive strain (Seeman, Singer, Rowe, Horwitz & McEwen, 1997; Selye, 1975). The excessive strain which occurs when exposed to chronic stress can lead to cardiovascular disease and hypertension (Lugar et al., 1988; Ottenweller, 2000; Seeman et al., 1997; Selye, 1976) and/or ischaemic heart disease (Sabbah, Watt, Sheihama & Tsakos, 2008).

Negative emotions such as anxiety, resentment and anger can decrease exercise tolerance, increase the pulse rate, the cardiac output and blood pressure (Baker, Suchday & Krantz, 2000; Selye, 1976). Defensive emotional patterns lead to the activation of the sympathetic nervous system where the hormone adrenaline is responsible for the neuromuscular activation. This causes an increase in heart rate and cardiac output with vasodilatation of skeletal muscle and might lead to coronary artery disease (Everly, 1989; Everly & Lating, 2002).

2.3.6 Step 6: Coping

Coping is defined as: “...constantly changing cognitive and behavioural efforts to manage specific demands that are appraised as taxing or exceeding the resources of the person” (Everly, 1989: 43).

Following the sequence of the stress response an individual will either be coping or not. If the individual is coping, then the stress response subsides and the resistance phase of the G.A.S. principle follows. The inability to cope is a major determinant in the presence of the stress response in each individual (Everly, 1989; Everly & Lating, 2002) along with emotional and
physical dysfunction (Figure 2.6 Stage 6). Even when emotional coping is absent, there are
distinct physical linkages between the soma/mind and the body. This is the link and explanation
for psychosomatic disorders and demonstrates a dependent relationship between the
psychological state of an individual, the physical state and one’s performance (Section 2.2.3.2)
(Baechle & Earle, 2000; Ottenweller, 2000; Selye, 1978). The manifestations of excessive stress
response and the result of not coping will be discussed in Section 2.3.6.2.

Figure 2.6 illustrates that the ability to cope causes attenuated activation and constant feedback
towards the earlier steps in the stress response. It also brings back stress to the optimal level of
the performance curve (Figure 2.3). Also, adaptive coping strategies, which promote long-term
health and decrease stress include: meditation, a proper eating plan and physical activity (Everly
& Lating, 2002; Steptoe, Edwards, Moses & Mathews, 1989, Steptoe, Kimbell & Basford,
1998).

2.3.6.1 Adaptation

In order for coping to occur and attenuate activation there needs to be adaptation. The ability to
adapt and resist is known as active coping which is also a behavioural outcome (Figure 2.7 Stage
4), and forms part of eustress (Mbaeyi, 1982; Patel, 1991; Selye, 1982). Constant adaptation is
accomplished by learning through experience and it is a more successful response than fighting
(Selye, 1974).

There are two types of adaptation: developmental (homotrophic adaptation) and redevelopmen
tal (heterotrophic) adaptation. Developmental adaptation is simple and progressive and is an
enlargement and multiplication of the specific organ’s cells, which occurs when a stressor causes
an increase on the demands of function placed on the organ, e.g. increased muscular work
(Selye, 1978). Redevelopmental adaptation is when a specific tissue (e.g. muscle tissue) is
organised to respond to one type of activity and then has to reorganise itself to respond to a
different kind of activity. An example of this is when a muscle cell undergoes metaplasia due to
phagocytosis by a pathogen or local stress promotes dedifferentiation and renewal of cells and
causes them to restructure themselves (Selye, 1978). In redevelopmental adaptation there is also
resistance known as specific and crossed resistance.
Following the alarm phase to a stressor, a “cross resistance” may develop which increases the resistance to another stressor (Selye, 1976). “Cross-sensitisation” is when there is summation of the potency of a stressor, because stressors present themselves simultaneously, thereby lowering the resistance (Selye, 1976). The non-specific exogenous agents usually act through cross-resistance and cross-sensitisation (Selye, 1976). The relevance of this information is that exercise may increase the resistance to a particular stressor through cross-sensitisation, thereby minimising the stress over the entire system and acting as an equaliser of activity (Buckworth & Dishman, 2002; Michael, 1957; Selye, 1976; Sothman, Claytor, Cox, White-Welkley & Dishman, 1996).

### 2.3.6.2 Diseases of adaptation

Adaptation plays a vital role in the stress response, since the ability to adapt determines whether or not the stress response will reach the various stages in the G.A.S. However, there are diseases that occur due to maladaptation, because there are unwarranted adaptive reactions against harmless stressors (Everly & Lating, 2002; Selye, 1978). The body has excessive demands placed on it and so it sets itself a higher standard at which the equilibrium needs to be maintained, therefore increasing the stress placed on the body and further leading the body to a state of exhaustion in the G.A.S., fatigue and finally to disease (Everly & Lating, 2002; Selye, 1978).

If a person with maladaptive coping strategies is exposed to an excessive mental stressor the individual perceives it as stressful. The stress response is initiated and the physical systems activated, the individual experiences increased physical stress, increasing the likelihood of physical fatigue. This aggravates the event and creates a larger activation of the system, creating more manifestations thereof and a possibility of disease as seen in feedback loop VI in Figure 2.6, and leading the body into a state of exhaustion (Blakenship, 2007; Everly, 1989; Everly & Lating, 2002). The manifestations worsen and become chronic to the point that disease results (Lundberg, 2000; Quick et al., 1997; Weinberg & Gould, 2007). This is a maladaptive disease caused by maladaptive coping strategies which can appear in a variety of ways and in any target organ.

Diseases of maladaptation are inter alia high blood pressure, myocardial infarction, peptic ulcers, muscular pains, migraine headaches, asthma, microvascular disease, heart disease, kidney and inflammatory diseases, rheumatic disease, eclampsia, allergies, nervous and mental diseases.

Hanna (2000) described the neuromuscular manifestations which result from excessive and chronic stress. According to him there are various muscular patterns which start at the centre of the body. The one which is affected by distress causes a withdrawal response forward and too much eustress causes an action response backwards. Jones (1965), Jones, Gray, Hanson and O’Connell (1959) and Jones, Hanson and Gray (1964) described a startle response which occurs whenever an individual is frightened or is “startled”. The response is completed within half a second and begins at the head and neck, travels inferiorly towards the trunk and legs. The neck musculature such as the upper trapezius and the sternocleidomastoid are constantly involved in the startle reaction and are the first to be activated. Since the position of the head orientates the bodily movement against gravity (Magnus, 1926a, 1926b), a change in its position as a consequence of the startle response can easily change an individual from good posture to malposture: a protracted and extended neck, dropped and extended head, kyphosis of thoracic spine, internal rotation and elevation of shoulder joint (Jones, 1965; Jones et al., 1959; Jones et al., 1964). One can assume that the startle response is integrated into the stress response, resulting in a muscle tension production which affects the whole body simultaneously (Alexander, 1985; Jones, 1965; Jones et al., 1959; Jones et al., 1964). If the diseases of maladaptation are not resolved, an individual may become further exhausted due to resulting chronic muscular tensions (Lowen, 1975; Lundberg, 2000).

Therefore the chronic stress response, the lack of coping and the resulting manifestations can cause diseases of adaptation. This in turn causes further activation of the stress response and a greater incidence of stress-related diseases.

2.3.6.3 Lack of physical activity as an ineffective coping strategy

Using physical exercise as a coping technique may prove useful when one looks at Kraus and Raab’s “Hypokinetic Disease” model. They developed the term “hypokinetic” (Kraus & Raab, 1961: 8), to be the reason for so much disease, as well as being a risk factor for development of disease. The basis of this model is that the presence of stress-related disease is not from the direct physiology present, but from the inability to express the physiological mechanism of the stress response. Somatosensory expression is a mechanism of protection, suppression of
somatosensory expression and activity leads to physical strain (Kraus & Raab, 1961). This physical strain is seen in the target organs (Section 2.3.5.1 and Section 2.3.5.2).

The lifestyle that most individuals lead today tends to be sedentary rather than active, a lifestyle that can be described as sedentarianism (Biddle, Gorely, Marshall & Cameron, 2009; Kraus & Raab, 1961). When there are periods of increased stress, sedentary individuals tend to develop stress-related diseases (Brotman, Golden & Wittstein, 2007). Whether the “stress-related illness” is mental or physical, the increase of disease is still due to decreased physical activity (Heyward, 2006). In this regard Kraus and Raab (1961: 4) stated:

“The system that has been put all but out of commission, the striated musculature constitutes a major part of our body-weight and has an important role which exceeds the mere function of locomotion. Action of the striated muscle influences directly and indirectly circulation, metabolism, and endocrine balance. It directly affects the structure of our bones, our posture, and the positions of our bodies. Last but not least the striated muscle serves as an outlet for our emotions and nervous responses the mean by which we react and respond to stimuli and emotional stresses. Obliteration of an important safety valve and constant suppression of natural responses, forced on us without the opening of vicarious outlets, might well upset the original balance to which the bodies of primitive man have been adapted.”

Most individuals do not engage in physical activity during their free time. The reason for this may be an increase in the dependency on technology and increased commitments such as family and work. As a result work-related physical activity decreases and available time for exercise has been minimised (Biddle et al, 2009). This situation results in a reduction of opportunity for the physical expression of the body (Kraus & Raab, 1961), as well as for energy expenditure and physical exertion (Heyward, 2006) and increases the (number) incidence of hypokinetic (Plowman & Smith, 2003) and chronic diseases (Casaburi et al., 1997; Fentem, 1994). Examples would include cardiovascular disease (hypertension, hyperlipidaemia and cardiomyopathy), musculoskeletal disorders (lower back pain), psychological disorders (anxiety and depression) and metabolic disorders (obesity and diabetes) (Heyward, 2006) which are similar to the diseases mentioned in Section 2.3.5, which occur when there is a chronic inflammatory response from stress (Chrousos, 2000). The combination of stress, the chronic inflammation and lack of physical activity causes a cocktail of disease manifestation and ineffective coping (Casaburi et al., 1997; Fentem, 1994).
There has been a growing concern about people’s decreased participation in physical activity. In order to counteract this situation participation in exercise is encouraged (Spence & Lee, 2003). Exercise can - and has - been used as a coping tool, and proved to be successful since the use of the physical body helps release the stored muscle tension and pent-up energy (Section 2.3.6.4).

2.3.6.4 The use of exercise as an effective coping strategy

Exercise is one of the natural therapeutic modalities and it is a biological necessity. It is necessary for sustained function and movement. Without it, the muscles would atrophy and the mind would wilt, and we would lose our efficiency and function (Bond et al., 2002; Sandlund & Norlander, 2000; Selye, 1974). Exercise is beneficial as it acts as a voluntary physical challenge, brings about positive emotions, brings a sense of freedom, satisfaction, control, it increases fitness and elevates mood (Buckworth & Dishman, 2002; Cox, 2002; Lovallo, 2005). Exercise also releases pent-up energy in the target organs, and provides a safe physical platform to relieve stress on the overloaded organs (Section 2.3.5.1 and Section 2.3.5.2). As will be later pointed out in Section 3.2.3, psychophysiological overload occurs when there is a failure of physical expression. Therefore, exercise is seen as a preventative, a treatment and a rehabilitative tool for disease and dysfunction (Buckworth & Dishman, 2002; Everly & Lating, 2002; Kerr & Kuk, 2001).

Physical activity also has a dominant role in holistic health, as it motivates individuals to take personal responsibility for their health and to reach a higher level of well-being (Asci, 2003; Cox, 2002). Exercise has been shown to have anxiolytic and antidepressive qualities, as well as giving the perception of an increased ability to cope (Bond et al, 2002; Chatzitheodorou, Mavromoustakos & Milioti, 2008; Cox, 2002; Kerr & Kuk, 2001).

Numerous studies support the use of exercise in order to gain mental and physical health benefits (Asci, 2003; Bond et al., 2002; Brooks et al., 2005; Chatzitheodorou et al., 2008; Cox, 2002; Dishman, Berthoud, Booth, Cotman, Edgerton, Fleshner, Gandevia, Gomez-Pinilla, Greenwood, Hillman, Kramer, Levin, Moran, Russo-Neustadt, Salamone, van Hoomissen, Wade, York & Zigmond, 2006; Gandee et al, 1998; Kerr & Kuk, 2001; Pérez, 2008; Quick et al., 1997; Rimmle, Zellweger, Marti, Seiler, Mohiyeddini, Ehlert & Heinrichs, 2007; Salmon, 2001) and for effective somatomotor expression, as well as for the prevention of disease and dysfunction (Cox, 2002; Kraus & Raab, 1961; Pérez, 2008; Quick et al., 1997; Rimmle et al, 2007; Salmon, 2001; Spence & Lee, 2003; Stein, Collins, Daniels, Noakes & Zigmond, 2007).
2.3.6.4.1 Types of exercise

Exercise training, which is exercise sessions that are considered to be done on a continual basis, has been shown to provide the best physical and psychological health benefits for the individual and acts as a buffer against stress (Cox, 2002). It is also considered an emotional coping method focused on reducing stress generated from a problem (Bond et al., 2002).

Despite much speculation, there are many modalities of exercises which have not yet been researched for the stress response. However, the positive effect of moderate aerobic exercise performed for approximately 20-30 minutes, 3-5 times a week, at an intensity of 55-90% of maximum heart rate on the individual, has been shown to decrease the intensity of the stress response (Bond et al., 2002; Buckworth & Dishman, 2002; Cox, 2002; Weinberg & Gould, 2007). Any relaxation exercises and techniques such as stretching, yoga and Tai Chi decrease the perception of stressors (Bond et al., 2002; Cox, 2002; Quick et al., 1997). The use and value of somatic awareness exercise will be discussed in Chapter 3.

2.3.6.4.2 The relationship between exercise and the human stress response

Exercise needs to be specific for each individual, because each stressor has a different effect on each individual and the mental perception of the exercise is an important contributing factor (Quick et al., 1997; Selye, 1974; Weinberg & Gould, 2007). If an individual participates in a particular type of exercise, of which he/she is not fond of, it is likely to increase the perception of stress rather than decrease it i.e. to cause distress (Figure 2.1) (Selye, 1974; Weinberg & Gould, 2007). However, if the activity is chosen out of enjoyment, excessive amounts of work or effort will not necessarily cause distress either (Selye, 1974) and may shift one to an optimal performance level (Figure 2.3) and induce positive long term behavioural changes (Figure 2.7 Stage 4).

There are several hypotheses as to why participation in exercise leads to a reduction in the stress response even though exercise causes the same physical reactions that are seen in the stress response. Some emotional responses elicit the same physiological responses that are seen in the participation of physical activity (e.g. an increased heart rate & increased blood flow) (Heyward, 2006; Martini, 2006). The responses which occur during physical activity are to accommodate for increased physical energy demands and increases in metabolism, but the physical responses seen in the stress response occur at near rest metabolism in preparation for the physical act of
fight or flight (Buckworth & Dishman, 2002). This means that the hypotheses are based on the mental reactions which occur during the stress response but they also overlap onto the physical reactions which occur during physical activity and in preparation for the stress response. Each hypothesis has been divided into relevant sections and discussed briefly below.

- Cross-stressor adaptation hypothesis of exercise: where increased levels of fitness are associated with a reduction in the stress responses which occur in non-exercise situations (Buckworth & Dishman, 2002; Michael, 1957; Sothman et al., 1996) (Section 2.3.6.1).

- Biological mechanisms and physiological theories include actual biological reactions which occur in response to exercise which might be the reason for the reduction in the stress response. The cardiovascular fitness hypothesis, the amine hypothesis and the endorphin hypothesis all relate to physiological changes such as: increased cardiovascular fitness; amine (neurotransmitter) increases; and endorphin increases. These physiological changes improve mental and emotional states (Cox, 2002).
  
  o Endorphin hypothesis: after exercise there is an increase in natural opioids which are known to enhance euphoria and mood changes (Buckworth & Dishman, 2002).
  
  o Serotonin: exercise causes increased free tryptophan in the blood stream, and since tryptophan is a serotonin precursor there is a chance of increased serotonin synthesis. Serotonin is an opioid which causes mood elevation (Buckworth & Dishman, 2002).
  
  o Thermogenic hypothesis: during and after exercise there is an increase in body temperature which is associated with improved mood (Buckworth & Dishman, 2002).
  
  o Gamma-amino butyric acid (GABA): exercise induces alterations in GABA which is an inhibitory neurotransmitter which decreases arousal and anxiety (Buckworth & Dishman, 2002).
  
  o Monoamine dysregulation hypothesis: there is an increased synthesis of monoamines, this in turn allows for alterations in the connections with motor neurons. The muscle sensory afferents then stimulate higher brain centres through the thalamus (Buckworth & Dishman, 2002).
  
  o HPA axis model: activation of this system through exercise re-regulates disruptions that have occurred (Buckworth & Dishman, 2002).
• Psychosocial/cognitive theories incorporate the psychological benefit of being in a social environment and from partaking in physical activity:
  o Mastery hypothesis: there is an increase in positivity after completion of a task, an important activity or an effortful feat such as an exercise session (Buckworth & Dishman, 2002).
  o Distraction hypothesis: exercise acts as a deviant from worry and mental stressors (Buckworth & Dishman, 2002; Selye, 1978).
  o Cognitive behavioural theory (de Coverley Veale, 1987) where exercise is seen to encourage and promote positive emotions and thoughts as well as bring about self accomplishment and self-efficacy. Positive thoughts then counteract the negativity associated with the stress response (Buckworth & Dishman, 2002).

By taking part in physical activity, there is a decrease in the stress response for a certain intensity or workload (Brooks et al., 2005; Lugar et al., 1988; Selye, 1974, 1978). The use of exercise affects feedback loops III and IV (Figure 2.6). The cardiovascular hypothesis, amine hypothesis and the endorphin hypothesis all support feedback loops III to IV because they all relate to the physiological changes which occur and affect the targeted organs of the stress response. By using exercise to increase the physiological mood elevators and by using exercise as a deviant from stressors (Cox, 2002), it feeds back along the stress response pathway to change the perception of the stress response through cognitive appraisal and affective integration.

The other purpose of physical exercise is to act as a stressor on the body resulting in adaptation, specifically redevelopmental adaptation (Section 2.3.6.1). This is accomplished through the G.A.S. (Section 2.2.3.5) (Selye, 1936, 1974). In the next section, the phases of exercise shall be merged with the three phases of the G.A.S., to explain how exercise can be used as a stressor.

2.3.6.4.3 Phases of exercise

As pointed out in Section 2.2.3.5, the three phases of the G.A.S. are the alarm, resistance and exhaustion phases (Selye, 1936, 1974). In the response to exercise, however, the individual experiences a two-phase process, namely a preparatory phase and an active phase (Lovallo, 2005).
Many studies describe the coordination and preparation of movement (Berrol, 2006; Funahashi, 2001; Stuart, 2005; Suzuki, Miyai, Ono & Kubota, 2007; Wiese, Stude, Nebel, de Greiff, Forsting, Diener & Keidel, 2004). These studies are important because they refer not only to the physiological and biomechanical adaptations which occur, but also the neuroscience behind movement. It is imperative to note the system in which movement originates. It appears that movement commences in the muscle tissue, in fact, before the actual execution of movement the neural system had already organised and coordinated the movement pattern (Nakata, Yoshie, Miura & Kudo, 2010; Suzuki et al., 2007). How can one look at the mental perception of stress, the emotional attenuation but not consider the brain as a primary mover of the body? Without the functional ability to organise movement, coordinate a movement pattern, or efferently affect muscle tissue, one cannot move nor will there be a preparation phase (Nakata et al., 2010; Suzuki et al., 2007).

After this sympathetic activation of the preparation phase, the active phase of exercise constitutes the initiation of exercise supercompensation also known as the alarm phase. It has already been said that the human stress response would benefit by a physical outlet such as physical exertion. This is seen by an increased blood supply to the muscles and cardiac tissue, increased neuromuscular tension, increased circulation of glucose and free fatty acids and with decreased blood flow to the gastrointestinal system (Everly & Lating, 2002). While exercising there is an increased oxygen - and energy demand, thus the heart rate, the cardiac output and the blood supply to the tissues, need to increase. There is greater cerebral communication through neural feedback from the muscular contractions, heart blood flow and peripheral blood flow changes (Lovallo, 2005). However the body’s ability to adjust to the stressors is limited and the body needs to adapt to the short-term stressor so that when it appears again in the future, the body can undergo allostasis without threat. This next shift is where adaptation to the stressor (exercise) occurs, and is termed the resistance phase (McEwen & Lasley, 2002; Selye, 1936, 1978).

The resistance phase involves increased neural efficiency, increased neural organisation and plastic changes in the cortical functioning of the brain. In addition, there is a greater ability to filter out irrelevant information (Nakata et al., 2010). The resistance phase occurs because of something known as the overload principle where exercise variables such as intensity, duration, repetition, recovery and frequency of training are applied correctly to exercise programmes (Brooks et al., 2005). By manipulating this principle one may increase the body’s ability to undergo redevelopmental adaptation (Section 2.3.6.1) and push the body into a state of
supercompensation, which is the ability of the body to restore what was utilised (e.g. energy) and to store that over and above the initial point. This allows for an increased baseline level and allows for extra reserves of energy, thereby increasing the resistance of the body to that particular stressor. When the stressor presents itself again, the body has now acquired a higher level of resistance and the use of exercise acts as a cross resistance via redevelopmental adaptation to further cause increased resistance (Bompa, 1999). The body then shows an improvement in exercise capacity and increases its energy reserves with greater organisation and control of movement. It allows the system to work at the same exercise intensity with more efficiency and less physical work (Brooks et al., 2005).

However, this resistance phase does not occur with every stressor or at any intensity. If the stressor is too weak, then no adaptation occurs and if the stressor is too strong, then overtraining and injury results. This ability of one to adapt and to determine how the system reacts to each type of exercise and its intensity is dependent on the individual, the level of training the individual is at, the particular sport, genetic factors, etc (Brooks et al., 2005). If exercise is overdone and there is not enough recovery due to incorrect application of the overload principle, then exhaustion results (Bompa, 1999). The final phase of exhaustion shall be discussed in Section 2.3.6.4.5.

2.3.6.4.4 Exercise and muscle tension

Muscle tension is a chronic manifestation of the chronic stress response (Section 2.3.5.1) (Everly, 1989; Everly & Lating, 2002; Lundberg, 2000; Orne & Whitehouse, 2000). Exercise has been shown to have an acute response which occurs shortly after cessation of exercise, and a chronic response which has a longer effect in the muscular system (Queiroz, Cagliari, Amorim, & Sacco, 2010). Examples of exercise which benefits the stress response and muscle tension are those which incorporate diaphragmatic breathing (Bond et al., 2002; Courtney, 2009). Breathing may then alter the apical breathing stress response patterns (Pfaltz, Grossman, Michael, Margraf & Wilhelm, 2010), thus one will want to induce parasympathetic breathing, which is slow, relaxed and diaphragmatic in nature (Courtney, 2009; Han, Stegen, de Valck, Climent & van de Woestijne, 1996; see Homma & Masaoka, 2008 for exact physiology).
The acute response is as follows: there is an increased core temperature; alterations in brain neurotransmitters; and an increase in secretion of endogenous opiates (serotonin and dopamine) that improves a person’s mood. This brings about psychological and physiological changes which cause a relaxation response and a decrease in the total muscle tension (Brooks *et al.*, 2005; Lundburg, 2000; Orne & Whitehouse, 2000).

### 2.3.6.4.5 Incorrect use of exercise acts as a stressor

It was explained in Section 2.2.6.4 that exercise is an effective tool for the suppression in elicitation of the stress response. However, excessive amounts of exercise can be deemed as an inappropriate stressor, can decrease performance and cause damage (Bompa, 1999; Brooks *et al.*, 2005; Buckworth & Dishman, 2002). This is usually seen with chronic intense exercise and is known as overtraining (Bompa, 1999; Brooks *et al.*, 2005), staleness and burnout (Buckworth & Dishman, 2002) (Figure 2.3).

If the exercise programme is of an extreme intensity, prolonged duration, increased frequency and repetition with little recovery, the body falls into a state of exhaustion (Figure 2.4). The reason is that the energy reserves that are depleted do not have ample time to be replenished and the body’s anabolism cannot keep up with the catabolism of training. Therefore the body is kept in an alarm phase without allowing the flow to the resistance phase (Bompa, 1999). The alarm phase cannot be maintained indefinitely and so the only option is the final stage of exhaustion, where the energy depletion is too great for repair of tissue, and as a result injuries and decreased performance are experienced (Bompa, 1999; Brooks *et al.*, 2005) (Figure 2.5).

It has been shown that out of all the exercise modalities and intensities, those that yield the best results for the management of stress are done in moderation and are of a pleasant nature such as somatic awareness exercises (Bond *et al.*, 2002; Kerr & Kuk, 2001; Macfarlane, Taylor & Cuddihy, 2006; Sandlund & Norlander, 2000). They allow for proper recovery and correct application of the overload principle (Bompa, 1999), for the body to replenish its energy reserves and to move into the phase of resistance so that adaptation can occur. There will also be an increased resistance to the stressor.
The relationship between exercise and an increased resistance to stress

Exercise disrupts the homeostasis of the body. The changes that occur are due to the body’s ability to respond to the demands placed on it (Plowman & Smith, 2003; Selye, 1974, 1978). Homeostatic mechanisms can maintain the normal state of resistance, but when faced with unusually heavy demands, ordinary homeostasis is not enough.

In order for the body to allostatically reach a higher state, there needs to be an external aid, which activates the dormant defensive reactions and increases the adaptation of the physiological adaptive mechanisms (Cutlip, Baker, Hollander & Ensey, 2009; Pérez, 2008; Selye, 1974, 1976, 1978). Enforced physical training at an appropriate load, which is an external intervention, can increase the physiological resistance level (Brooks et al., 1972; Kobasa, Maddi & Puccetti, 1982; McEwen & Lasley, 2002; Rimmelle et al., 2007; Salmon, 2001; Selye, 1974; Sterling & Eyer, 1988), thereby resetting the feedback mechanisms to raise the level of defence producing substances to demands which are placed daily on the individual (McEwen & Lasley, 2002; Selye, 1974) (Figure 2.3 and Figure 2.5).

The use of exercise also affects the CNS through activation of the brain circuits responsible for parasympathetic nervous system (PNS) activation and constraint on SNS responses, therefore resulting in decreases for all SNS effects and allowing for greater brain function and performance of a cognitive nature (Dishman et al., 2006; Stein et al., 2007). For these reasons exercise potential has been used in trauma, anti-aging and disease. This has been shown through hormesis (Kitchin, 2002).

Hormesis is “a process in which exposure to a low dose of a chemical agent or environmental factor that is damaging at higher doses induces an adaptive beneficial effect on the cell or organism” (Mattson, 2008: 1). The process of hormesis can be initiated by exposing one’s self to an external stimulus, in this case it is exercise. If one looks at the biological perspective, exercise can bring about cellular hormesis which may be activated through intrinsic signalling pathways (Mattson, 2008). This causes a mild cellular stress which causes a protective or defensive adaptive stress response through energy regulation and gene transcription, exercise is known to increase resistance to the muscular and cardiovascular systems, but it may also increase resistance of the neural system, digestive systems, antioxidant pathways and the entire body to stress (Mattson, 2008; Sonneborn, 2010). This demonstrates how exposure to low levels...
of one hermetic agent (e.g. exercise) may protect one against multiple sources of stress, thereby a “cross-modal” or “cross-sensitisation” effect (Mattson, 2008) (Section 2.3.6.1).

This cross-modal effect has been mentioned by Buckworth and Dishman (2002); Michael (1957); Selye (1978) and Sothman et al. (1996) (Section 2.3.6.4.2). By using moderate exercise as a stressor, and as a hermetic agent there is a cascade of gene expression which is seen in the prevention and treatment of infection, aging, trauma and disease (Sonneborn, 2010). In Section 2.3.6.4.3, it was explained that exercise is used to aid the body to reach a level of supercompensation and how exercise can aid redevelopmental adaptation. This is important, because the proposed evidence (Section 2.3.6.4 – Section 2.3.6.4.4) on exercise, which is to be used in the present study, indicates that exercise increases resistance to stress (Bond et al., 2002; Kobasa et al., 1982).
CHAPTER 3

SOMATIC AWARENESS

“…the state of being attentive to and aware of what is taking place in the present” (Brown & Ryan, 2003: 822).

Somatic awareness, mindfulness, body-awareness, kinaesthetic awareness (Dunbar, 1949) and kinaesthesia are encompassing terms to explain the ability to sense the position, location, orientation and movement of the body and limbs (Oxford University Press, 2012). Kinaesthesia, which is not to be confused with proprioception, is the “conscious awareness of the joint positions and movement, resulting from proprioceptive input” and “neural input to the nervous system” (Voight, Hardin, Blackburn, Tippett & Canner, 1996: 348). The term kinaesthesia originates from late 19th century Greek “kinein”, which means to move and “aisthess”, which means sensation (Oxford University Press, 2012). Somatic awareness, therefore, is the ability to consciously sense or allows one to have “interoceptive kinaesthetic sense” (Myers, 1998: 102) or in the words of Bakal, Steiert, Coll and Schaefer (2006: 1444):

“Our total well-being depends on somatically aware efficient and fluid movement (Bond et al., 2002; Brooks et al., 2005; Chatzitheodorou et al., 2008; Cox, 2002; Gandee et al., 1998; Kerr & Kuk, 2001; Kraus & Raab, 1961; Pérez, 2008; Quick et al., 1997; Rimmelé et al., 2007; Salmon, 2001), for effective somatomotor expression, as well as for the prevention of disease and dysfunction (Cox, 2002; Kraus & Raab, 1961; Pérez, 2008; Quick et al., 1997; Rimmelé et al., 2007; Salmon, 2001; Spence & Lee, 2003). Movement that is efficient can be developed from having increased somatic awareness. This is important since movement has emotional, mental and physical implications. Somatic awareness may induce well-being or a good emotional state of emotional and mental tranquillity (Feldenkrais, 1972, 2002; Loots, 1999; Loots, 2010).”
Somatic awareness creates well-being in the body by encompassing somatic education and functional integration. Functional integration is learning to appreciate your self, not as a body, or as a mind, or as a self, but as a whole systemic integrated human being. The habitual patterns of behaviour, observable in humans, is very much a mirror to the conscious somatic state, and this conscious somatic state is what we know as personality and character (Feldenkrais, 1972; Hanna, 1993; Reich, 2002). In this regard, Bakal et al. (2006: 1445) observed that: “the body is the unconscious mind.” We thus find that a stressed person will have a stressed body, an angry person will have an angry body and an anxious person will have an anxious body.

Since the body is the unconscious mind, there is a multifaceted relationship between psychological states and bodily health (Bakal et al., 2006), and any improvement in internal somatic sensation will increase improvements in function (Hanna, 1993). This change in human function occurs because human beings are the only living creatures capable of self transformation and self correction (Hanna, 1993) and this means that what movements and “states’ we have learnt, may be unlearnt and replaced following on new information (Alexander, 1985, 1987). This is a very exciting prospect because what modern medicine had us believe is unchangeable, is actually changeable (Hanna, 1993; Myers, 1998), which means that ingrained habitual patterns of stress may be reversed. As much as reductive medicine tries to segregate the body, mind and self, biopsychosocial medicine has merged all three (Myers, 1998) into the functioning unit and being that man actually is: into a indissolvable unity of soma (Hanna, 1993).

3.1 Benefits of somatic awareness

Somatic awareness has many benefits, this section will commence with the basic skills that somatic awareness improves and provides, to then explain the applications of those skills. Application of somatic awareness techniques provides the skill to differentiate between a few grams of mass (Loots, 2010) and the knowledge between interoception (internal awareness) and enteroception (external awareness) (Blakeslee & Blakeslee, 2007; de Preester & Knockaert, 2005). It also encourages one to increase awareness of what is occurring in the soma by improved interpretation of feedback (Brown & Ryan, 2003; Hanna, 1993; Myers, 1998), allows somatic communication to be transcended to the higher self (Alexander, 1985; Polsgrove, 2008; 2012; Williamson-Scott, 2007), increases the awareness of unconscious patterns of behaviour, teaches one to inhibit “bad” habits, while educating one to be more efficient (Alexander, 1985, 1987), and there is a transformation of understanding through conscious and unconscious integration (Brown & Ryan, 2003; Hunter & Csikszentmihalyi, 2000; Jeannerod, 2007;
MacDonald, 1998) and coordination (MacDonald, 1998) which allows for improvement in internal somatic sensation.

Alexander (1985) emphasised the importance of being taught the correct sensation of movement, since often what one does and what one thinks they are doing correctly is not what actually is correct. This means that one must be able to have heightened sensation to differentiate between what is correct and what isn’t. This ability to develop sensation [or kinaesthetic awareness (Myers, 1998)] is in itself an experience unique to every individual (Savitzky, 2001). It is unique because every individual will conceptualise physical data, such as vibrations, sound waves, light waves and angles, obtained from the sensory organs, into touch, hearing, sight and position (Savitzky, 2001). The interpretation of sensory information is possible because of constant feedback provided by the sensory organs (Martini, 2006). Feedback is always provided by the body, however when one is stressed the focus of attention changes and less awareness is placed on the interpretation of feedback (Bartholomew, 2000; Gallwey, 1975). This causes one to misinterpret or even “miss” important information (Gallwey, 1975; Wild, Clark, Ehlers & McManus, 2008). Becoming more aware somatically aids in promoting attention and awareness to feedback, so that one can alter and adjust movements and bodily action. In this regard, Hunter and Csikszentmihalyi (2000: 13) pointed out:

“…feedback often comes from the sensations of the body itself. As it moves through space, the body provides information relative to the goal. By simply paying attention to the minute stances of the body an athlete is able to make judgements about her status.”

Thus, by increasing somatic awareness one can increase the ability to accurately interpret feedback (Brown & Ryan, 2003; Hanna, 1993; Myers, 1998) through feedback loops I-IV (Figure 2.6). The interpretation of experiences is unique to each individual and is stored in the brain as kinaesthetic memories, and not as learnt patterns (Savitzky, 2001). Thus increased somatic awareness can help one’s ability to accurately interpret sensory information and what is sensed, perceived and experienced (Hanna, 2004) as well as to develop the correct “use” of the self (Alexander, 1985; Bobath, 1980; Loots, 2010; Polsgrove, 2008, 2012).

The awareness of the self is a concept that is unique to man (Casas & Tranel, 2008; Dietrich, 2004a; Haken, 2006; Thelen, 1995) and there are primarily two selves: an embodied (egoless) and narrative (ego) self (see Gallwey, 1975 and Jeannerod, 2007). If the narrative self is enhanced the result is sensory deficiency (Section 3.3). If enhanced, the embodied self is
responsible for the decreased internal resistance (Feldenkrais, 1972), decreased parasitic pattern
development and increased movement efficiency (Feldenkrais, 1972; Loots, 2010; Polsgrove,
2012; Thelen, 1995; Ulrich, Ulrich & Angulo-Kinzler, 1998) good posture, pleasurable
movement, *poise* and improved use of the self (Dart, 1947; Feldenkrais, 2002). One may then
differentiate and chose between executing a parasitic pattern (see Section 3.3) and an efficient
movement pattern (Alexander, 1985; Feldenkrais, 2002; Hanna, 2004), thus increasing the ability
to make correct movement choices. In effect these movement choices may include: changing
motor patterns, kinaesthetic memories and behavioural patterns (Feldenkrais, 2002; Hanna,
1993; Loots, 1999; Lowen, 1975; Reich, 2002). Since these improvements could improve the
functioning of the system as a whole, there may also be improvement in the chronic stress
response patterns.

When one changes the behavioural patterns and the stress response patterns as Reich (2002) tried
to do, one is able to express the self more effectively. Bloom (2005: 56) emphasised the
importance of allowing the body to express itself through movement:

"The articulation of experience is therefore rooted in two languages-that of the body in
movement and that of the mind in thought. ···It is through allowing the body to experience and
speak for itself that the depths of preverbal experience can potentially be reached."

Somatic awareness allows the body to speak for itself and to develop a dynamically optimal
system. A dynamically optimal system is free from tension and exhibits easy use (Alexander,
1987; Feldenkrais, 1972; Hanna, 1993; Howorth, 1946), is relaxed, shows efficient muscular
energy use, has increased mechanical efficiency (Hanna, 1993), is balanced, timing and rhythm
sequences are correct (Howorth, 1946), while parasitic movements and unnecessary muscle
effort are limited (Alexander, 1985; Feldenkrais, 1972; Howorth, 1946; Loots, 1999). This could
then lead to physical comfort, improved gait, improved muscle integration (Hanna, 1993; Loots,
1999), greater centre of gravity control, decreased body sway (Hellebrandt, 1938) and decreased
demands on the striated muscle fibres (Loots, 1999).

### 3.2 A brief history of somatic awareness

Many body work practitioners such as Frederick Mathias Alexander (1985), Moshe Feldenkrais
successfully used somatic awareness techniques to treat a variety of physical ailments such as
bodily pain and injury, as well as for emotional and mental ailments such as depression and anxiety. There is some evidence that the treatment of the body has an effect on the mind of an individual and vice versa (Alexander, 1996; Feldenkrais, 1972, 2002; Hanna, 1993, 2004; Myers, 1998).

From practitioners in the field of somatic awareness or bodywork, the concept of somatic awareness has grown and has been used in various rehabilitative settings. Several papers have confirmed that mind-body medicine, and in essence somatic awareness may be used to decrease certain psychosomatic symptoms (Astin, Shapiro, Eisenberg & Forys, 2003; Bakal, 2001; Bakal et al., 2006; Comeaux, 2005; Ernst, Pittler, Wider & Boddy, 2007; Gyllensten, Hansson & Ekdahl, 2003; Landsman-Dijkstra, van Wijck, Groothoff & Rispens, 2004; Rosenholtz, 2001), decrease parasitic movement and promote quality of function (Alexander, 1996; Cranz, 2000a, 2000b; Comeaux, 2005; Gyllensten et al., 2003; Mills & Allen, 2000; Polsgrove, 2008; 2012; Stallibrass, Frank & Wentworth, 2004). A brief history on the development of somatic awareness will follow, viewing the contribution of five prominent movement practitioners of somatic awareness.

3.2.1 Frederick Matthias Alexander, an actor who had his head in the game

Frederick Matthias Alexander was an Australian actor who developed serious vocal trouble, and with the medical profession unable to help him, he took matters in his own hands, by observing himself in a mirror. During a series of agonizing years he worked out how to improve the use of his body musculature. According to the Nobel Prize Laureate, Professor Nikolaas Tinbergen, this story of perceptiveness, of intelligence and of persistence is one of the true epics of medical research and practice (Tinbergen, 1973). Alexander was the first worker in the field of somatic awareness and bodywork to stress the existence and problem of a defective kinaesthetic system in Western man (Alexander, 1996). He also stressed the importance of being able to observe and wonder when too often basic effective methods are lost by those blinded by the use of equipment and the use of resistance exercises. When the first edition of his book The Use of the Self was published in 1932 the British Medical Journal called it a classic: “a classic of scientific observation” (Barlow, 1985: 9). What Alexander had observed was the use of the head and the back in psychological and physical functioning. He found that we misuse our bodies and then in turn found a method to re-order the habits of misuse. The importance of this is the prevention of misuse of the various bodily mechanisms and prevention of the wrong use of the body parts. In this regard Alexander (1985: 33) stated that:
“The belief is very generally held that if only we are told what to do in order to correct a wrong way of doing something, we can do it, and that if we feel we are doing it, all is well. All my experience, however, goes to shew\textsuperscript{1} that this is a delusion.”

3.2.2 Moshe Feldenkrais: Muscles mean movement

Moshe Feldenkrais was a Russian born Israeli, with a DSc. in Physics from the Sorbonne. An old injury incapacitated him, with little hope to ever walk normally again. He then applied his extensive knowledge of anatomy, physiology, psychology, physics and martial arts to restore his own normal functioning by increasing bodily awareness. He later became a teacher of his own method (Loots, 2010). Feldenkrais believed that awareness of human movement was important in order to understand the human body. The core of his concept was developing somatic awareness by utilising kinaesthetic sense. Feldenkrais (2002: 37) noted that:

“Our every action is manifested through the muscles.”

The importance of this statement cannot be stressed enough. Feldenkrais here in one sentence explains how the entire human reaction and response, whether it be emotional, mental or physical is done through muscle tissue, and that our muscular system is the link between the internal and external environments. In this he accented the importance of the awareness of the relationship and integration between the mind and the soma and the core concept of this research. It is through the ability to be somatically aware that one may link “everything we do” to the body’s musculoskeletal system.

3.2.3 Wilhelm Reich: Dis-armour thyself

Reich (1973) was known as a controversial scientist, a medical doctor, a psychiatrist and a psychoanalyst. He studied biological energy and linked the relationship between the emotional, physical and psychological to biological energy. He discovered that the expression of physical energy originates from the emotions and from the psychological component of an individual. An example of his “discovery” was that that patients used to hold their breaths and limit exhalation in order to limit emotional release, which resulted in muscle tension or muscle hypertonia. The manner in which one held their muscle tension was dependent on one’s character, personality

\textsuperscript{1}Shew = show.
and emotions, known as character armouring. The failure to express one’s emotions meant that
the energy was bound to the muscular system and therefore creating muscle tension as when one
limits exhalation (Reich, 1973) (see Section 2.3.5.1).

If the mental emotions could be expressed through the physical body this means that there was a
direct mind body link (Reich, 1973) and the awareness and use of the mind body link can be
used to manage and treat physical muscular disorders. His work consisted of the correct use of
breathing, sexual energy, psychology and physical movement in order to express the bound
physical energy through the muscular system. Once the energy had been released there was no
need to waste the energy to support or hold the tensions and neurotic tendencies. This means
that one may use the physical act of movement to release one’s mental and emotional
exacerbations.

3.2.4 Alexander Lowen: Breathing, release and energy

Alexander Lowen was the founder of a concept known as Bioenergetics, where exercise is used
to treat the mental and emotional tensions and frustrations that individuals experience. Lowen
(1975) based his work on that of Wilhelm Reich whose work in turn was built on the concept
that bounded energy that cannot be discharged is maintained in chronic muscular tensions or
muscular armouring (see Section 3.2.3). Lowen used human movement to release this
armouring through a series of somatic exercises and movements. By using the mind-body link,
through the physical body Lowen was able to release the pent-up emotion muscle tension and to
promote muscle relaxation (Lowen, 1975; Lowen & Lowen, 1977).

3.2.5 Thomas Hanna: The concepts of the archesoma and Sensory-Motor Amnesia (SMA)

Thomas Hanna contributed immensely to the field of somatics and somatic education, because
he understood that somatic awareness is a physiological function, and not a spiritual, mental or
psychological function (Hanna, 1993, 2004). Becoming somatically aware is not about
commanding one to live within a new system, or to apply therapy, or remove information, but
rather to educate, to add knowledge, and develop control over bodily processes by using this
awareness to become aware of the self. Somatic awareness then is about teaching individuals to
be aware and free in the system in which they live (Hanna, 1993, 2004).
According to Kelso (1998), research in coordination dynamics consistently shows that generic dynamical mechanisms are exploited by living things (e.g. vertebrates) to provide both flexibility and stability of motor function. These mechanisms appear so often because these organisms and environments have co-evolved in such a way that those regularities and styles of change that work well are selected. An example of these selected styles would be the development for a life on land after the development from a life in water by altering the positions of the limbs (Kelso, 1995). Hanna (1993) referred to these mechanisms as the ancient archesoma, which forms the foundation of human movement as Hanna (1993: 194) pointed out:

“The archesoma is a basic system of movements possessed by all species of creatures, undergirding their behavior and determining the efficiency of their actions.”

This foundation of human functioning is not pre-programmed, we are not born with installed motor programmes, but rather we find that human functioning is a self organising and a self regulating neurophysiological integrative system (Lewis & Todd, 2007). The system is able to integrate conscious and unconscious information, modify both higher order functions and the neuromuscular system and functionally integrate human movement in relation to the environment (Hanna, 1993). Therefore, encompassing the embodied self (Bloom, 2006) or implicit self into one functioning unit (Dietrich, 2004b; Dietrich & Audiffren, 2011). The archesoma (Hanna, 2004) shares many similarities with the implicit system\(^2\) of Dietrich and Audiffren (2011), and they may be assumed to be same concept. Like the archesoma the implicit system is neuroscientifically known and defined as an older and more primitive ancient system and the expression of this system is primarily through task performance and movement (Dietrich, 2004b; Dietrich & Audiffren, 2011; Jeannerod, 2007). When the implicit system is activated, it is highly efficient, bypasses higher order brain functions and creates its own internal mental representation of “muscle memory” (known erroneously as stored muscle memory) (Dietrich, 2004b) and allows movements to be executed fast, efficiently and with real time sensorimotor integration (Dietrich & Audiffren, 2011).

\(^2\) The implicit and explicit systems are specialised information processing cognitive and knowledge representation systems. The implicit system is an ancient evolutionary system, which is based on experience and skill, and can only be expressed through motor and task performance. This is because the content of the implicit system is not accessible to conscious awareness, is not utilised by any other functional system in the brain and cannot be transferred verbally. Thus, it is not a part of working memory, nor is it conscious, nor is it bombarded with higher order conscious representations which increase computational complexity, this allows motor skills and movement to be more efficient. In contrast, the explicit system which is assumed to lie in the prefrontal cortex would be exceptionally inefficient in controlling motor tasks because it represents information in a higher-order, is rule-based, conscious and its content can be expressed verbally (Dietrich & Audiffren, 2011).
Hanna (1993) also indicated that the correct use of the somatic awareness of the self and the soma through movement increases the functioning of the archesoma through the integration of the conscious and unconscious (archesomatic) functions. However, man is an acting “self” (Armstrong, 1993; Loots, 1999) and the quality of movement and the efficiency of the psychological and physiological systems are direct reflections of the proper functioning of the archesoma as Hanna (1993: 194-195) pointed out:

“The condition or the function of the archesoma is objectively observable by its patterns of movements and subjectively observable by the proprioceptive sensations of these movement patterns.”

Hanna (1993: 194) outlined the importance of the archesoma, thus:

“All human functions—physiological, psychological, emotional, and so forth—are direct reflections of the state of the archesoma, which operates at the core of these functions, rendering them either more effective and coordinated or less so. The archesoma is the precondition for all specific movements: If the core is distorted, so will the specific physiological, psychological, perceptual, judgmental, and all other functions be distorted and less effective.”

Therefore, if one has a “broken archesoma” or if the archesoma is not functioning properly due to, amongst other things, limited somatic awareness, dysfunction and sensory motor amnesia (SMA) results. Sensory motor amnesia is known as an habitual state of forgetfulness where one “forgets” the feeling of one’s own muscles and control of them (Hanna, 2004), resulting in the compromise of one’s emotional (psychological) component and motor behavioural patterns (physiological) [as seen in stress response patterns (Section 2.3.5.1)], as Hanna (1993: 196) observed:

“In adults whose proprioceptive senses have atrophied, the workings of the archesoma seems to be nonexistent. There is a schism between conscious functions and the archesomatic functions. When this occurs, the archesoma, unobserved and unguided, can become distorted and inefficient, thus distorting the entire human system, rendering the human being clumsy and uncomfortable.”
Hanna (1993: 196) then went on to explain that the only way to eliminate SMA or to remember one’s muscles and archesoma and to be made aware of them, is to increase one's somatic awareness:

“When such an event occurs, it is of little use to address the psychological or the physiological structure; what is required is an improvement in the archesoma. This can take place only by becoming aware of the archesomatic functions and gaining greater range, coordination, and balance of these basic movements.”

3.3 Sensory deficiency

The lack of somatic awareness (sensory deficiency) or kinaesthetic ignorance is what Myers (1998) referred to as an epidemic of the 21st century, because as a group modern man lacks self-discovery in both a physical and mental sense and as a society is lacking feeling, touch and awareness. In this regard, Myers (2008: 109) pointed out that:

“It is this general lack of attention to the kinaesthetic sense which has produced what we are calling 'kinaesthetic dystonia'; an epidemic of unnecessary parasitic muscle tension and structural pain, early degeneration due to dis- or misuse of body parts, alienation from purpose and free emotional expression, and a reliance on what can be seen and heard over what can be felt.”

In fact, man is suffering from “broken archesomas” (Hanna, 2004) and sensory motor amnesia, and the consequences of SMA are:

- the presence of an unconscious muscle contraction,
- decreased ability to control one’s musculature (Hanna, 2004),
- muscular imbalances that one is not aware of (Janda & Schmidt, 1980; Loots, Loots & Steyn, 2002) and
- parasitic movements [movements which waste energy, lack energy dissipation, integration and strength, are uneconomical and inefficient in biomechanics (Alexander, 1985; Feldenkrais, 1972, 2002; Hanna, 2004; Loots, 2010; Lowen, 1975; Myers, 1998; Polsgrove, 2012; Reich, 2002; Seaman, 1997)].
3.3.1 Sensory Motor Amnesia and stress

SMA may occur as the consequence of the activation of chronic stress response patterns (Section 2.3.5.1). The problem, however, is not solely due to the constant execution of muscle patterns with excessive tension, but also the execution of patterns which lack somatic awareness. When stress response patterns and motor patterns lack somatic awareness, there is limited interpretation and communication in terms of what one is sensing. This limits the ability to “unlearn” a parasitic pattern and learn an improved motor solution. Thus, any concerted effort to change a motor pattern that lacks somatic awareness will indeed result in a different pattern, but unfortunately a pattern that still lacks somatic awareness and is parasitic in nature (Alexander, 1985; Loots, 2010).

This parasitic stress pattern results in a chronic tonus or muscle tonicity of approximately 10-40% above the level of complete relaxation. Then the constant actin-myosin binding leads to muscle hardening (Hanna, 2004). The increased muscle tonicity decreases the joint range of motion and there is a motor adjustment (muscle recruitment) to compensate for decreased movement at that area (Seaman, 1997). Although the muscle recruitment may be a short term solution to attempt to compensate for the limited joint range due to hypertonicity, the long term outcome of chronic muscular hypertension from stress is habitual SMA with an increased emotional intensity (Orne & Whitehouse, 2000). This may be associated with decreased muscle reaction (Feldenkrais, 1972, 2002; Gandee et al., 1998), increased tendon reflexes, increased muscle excitability (Alexander, 1985; Feldenkrais, 2002; Lowen, 1975; Lowen & Lowen, 1977), smooth muscle spasticity (Hanna, 1993, 2004; Lowen, 1969, 1975), increased level of excitability in the cardiovascular system (Selye, 1976), as well as in the respiratory system (Lowen, 1975; Lowen & Lowen, 1977), decreased range of motion (Alexander, 1985), muscle tremors (Reich, 2002), and restlessness (Dunbar, 1949; Lundburg, 2000).

The result of these reactions is chronic pain, bodily stiffness, misalignment and poor posture. This creates a “vicious circle” where the accumulation of these reactions further decrease stress tolerance, decrease self expression and result in an exacerbation of the stress response (Feldenkrais, 2002; Hanna, 2004; Loots, 1999; Lowen, 1975).
3.3.2 The biomedical model: A cause for SMA

In modern society one wonders why SMA continues to be an epidemic. This is probably due to the reductionistic or remedial manner in which movement education has been approached (Myers, 1998), and an over dependence on the mechanistic and dualistic Cartesian biomedical model (Astin et al., 2003; Bennett & Hacker, 2002; Capra, 1985; Hunter & Csikszentmihalyi, 2000).

Although, the biomedical model has had its successes and applications when addressing various acute physical ailments such as a perforated ear drum, its success, however, is limited when it comes to chronic conditions (Hunter & Csikszentmihalyi, 2000; Myers, 1998). The shortfalls of this model can be seen when treating a highly stressed individual where there is often administration of prescription medication and muscle relaxants (treating the parts and their symptoms) (Bakal et al., 2006). This biomedical approach further limits somatic awareness and creates a rift between the body and the self, segregating it into parts (Hunter & Csikszentmihalyi, 2000; Myers, 1998). This rift occurs because the biomedical model assumes the diseases manifested and their treatment can be segregated in the same manner. It also addresses the symptom or symptoms of the problem, and not the problem itself (Astin et al., 2003; Bennett & Hacker, 2002; Hunter & Csikszentmihalyi, 2000). One should consider the whole person (Hunter & Csikszentmihalyi, 2000; Myers, 1998) and rather determine the real causes of the depression, muscle tension and stress, and teach somatic awareness in order to cope with the problem (Levine, 2005; Myers, 1998). Bennett and Hacker (2002: 48) pondered on this theme in neuroscience and came to the conclusion that:

“The Cartesian error that is perpetuated by current neuroscientists is the mistake of ascribing to part of a creature attributes which can logically be ascribed only to the creature as a whole. We have dubbed this ‘The Mereological Fallacy’ in neuroscience (mereology being the logic of part/whole relations).”

The author of the present study is of the opinion that medication will not “cure” the faulty archesoma, and according to Alexander (1996) neither will physical gym based exercise. The reason why the gym based exercises would not be successful is because there is still a defective kinaesthetic system present, decreased control of the self, flawed sense-registration and incorrect inhibition of incorrect movement patterns resulting in no change in the movement patterns, or one’s awareness of the self. This aspect will be discussed in greater depth in Section 3.4.1.
Current physical education and physical therapy unfortunately place little emphasis on awareness and assume that movements and movement patterns are fully formed and in a linear fashion (Myers, 1998), where in actual fact movement is dynamic, and constantly developing in an idiosyncratic manner (Myers, 1998; Smith & Thelen, 2003). Myers (1998) also examined the emphasis on cause-and-effect correction and lack of integration and development, and the need to shift the focus on teaching movement education and develop the underdeveloped movement foundation. Accepted practices such as aesthetic emphasis in gymnasia (i.e. sucking in abdominals to appear thinner which restricts diaphragmatic breathing) and sedentary working environments further exacerbate the problem. The lack of somatic awareness education and training in approaches to motor control needs to be addressed urgently, because the number of “healthy” individuals who are experiencing bodily pain, muscle tension and seeking out movement practitioners has increased dramatically (Myers, 1998).

3.4 The Biopsychosocial Model: Using somatic awareness to break the Cartesian error

“It is a Cartesian error to suppose that it is the mind that feels pain, perceives, thinks and reasons, remembers and wills to act. For it is not the mind that feels a headache or a toothache, but the person whose head or tooth aches (the mind has neither head nor teeth). It is not the mind that sees (it has no eyes) or hears (it has no ears) but the living human being. And it is not the mind that thinks, reasons, remembers and forms intentions but the person.”

Here Bennett and Hacker (2002: 48) described the error in the segregation of parts, and as a result of the dualistic incompetence in managing movement disorders, pain syndromes, stress related illness and psychosomatic pathologies. The holistic biopsychosocial/integrative model has become a popular tool (Capra, 1985, 1997; Myers, 1998) and should be used in treating medically unexplained symptoms since it provides a philosophy of care (Bakal et al., 2006), which is cost effective and with no side effects (Astin et al., 2003; Myers, 1998). It also encourages the belief that every disease is neither entirely psychological nor entirely physiological (Levine, 2005). Disease is a “living event” which needs to be understood in an integrated manner because there is unity between the psychological and physiological (Alexander, 1985; Bakal et al., 2006; Dunbar, 1949; Rosenholtz, 2001).

Much the same as the general systems theory (Laszlo, 1972, 2006, 2007) and what Hanna (1993) proposed in terms of the archesoma, the integrative/ biopsychosocial model has no element which has causal priority (Smith & Thelen, 2003), it disproves a single relationship and instead
recommends a sub-system of relationships, in which there is constant dynamic interaction of a human being and not broken parts (Laszlo, 1972, 2006, 2007). The components of the system are not living beings but are living structures or living components of the living being and should be regarded as such (Lewis & Todd, 2007; Polsgrove, 2012; Savitzky, 2001). In this respect Hunter and Csikszentmihalyi (2000: 15) stated:

“As you have no doubt noticed by now, none of this discussion has been formulated in terms of "mind versus body," the phenomenology of flow demonstrates the fallacy of trying to split the two because the nature of the experience demands that mind and body work in harmonic unison. The flow experience relies on mental constructs like goals and mental abilities like concentration and awareness of feedback to understand and guide the body. In essence, there is no separation. This is not a dictatorial relationship with the body supplicating to the mind, but a dialogue between equals.”

Of course breaking the “Cartesian” error of dualism and mending the distorted archesoma cannot be achieved through reductive, mechanistic or dualistic medicine, as it was not successful in managing the chronic stress response successfully (Hanna, 1993; Hunter & Csikszentmihalyi, 2000). In order to rid oneself of duality and break the “Cartesian” error, one must merge the dualistic rift between the self and the body (Hunter & Csikszentmihalyi, 2000; Lowen, 1969; Myers, 1998), by teaching somatic awareness in order to transcend to a higher state and integrate the psyche and the soma, to where there is only one being (system) with integrated unified parts (Bakal, 2001).

3.4.1 The development of kinaesthetic awareness

“...it is not enough to know, but we must try to have and use it, or try any other way there may be of becoming good” (Aristotle: Oxford World’s Classics, 2009: Book X: 1179b).

The development of kinaesthetic awareness is dependent on learning the art of good movement, but also in knowing how to use oneself to achieve good movement. The development of a heightened somatically aware kinaesthetic memory was a constant goal by movement practitioners such as Alexander (1985), Hanna (1993) and Feldenkrais (1972). Their aim was to teach somatic awareness through movement in order to facilitate learning and develop beautifully efficient movements emanating from the archesoma (Hanna, 1993). Somatic awareness may be taught in a variety of ways and settings, and amongst other things, needs to be
increased in the domain of physical education. Currently, however, movement is taught incorrectly (Myers, 1998). Hunter and Csikszentmihalyi (2000: 6) stated:

“In the case of sports, they are often thought of as a purely physical action, as exemplified by much of the mindless activity that passes for physical education in our schools. In this purely physical mode, the constructive role of the mind is generally ignored in favor of numbing militaristic drills of counting push-ups, sit-ups and pull-ups in an effort to make a "physically-fit," if not also alienated, student.”

Alexander (1996) did not believe in the use of physical exercise to improve oneself, since he emphasised that exercise should not be based upon:

“···the most primitive forms of dumb-bell exercise, or to the most elaborate series of evolutions designed to counteract the effect of a particular malady” (Alexander, 1996: 9).

Nor should it stand for:

“···a series of mechanical exercises, simple or complicated, designed to strengthen a bodily function by the development of a set of muscles or of the complete system of muscles···” (Alexander, 1996: 9).

Thus, when teaching somatic awareness, exercises that should be avoided are the exercises which do not instil movement knowledge and somatic awareness: gymnasium based exercises, resistance exercise and isokinetic based exercise on equipment, as these techniques focus on single joint, isolated muscle work and improvement in “fitness” parameters (Alexander, 1996; Loots, 2010; Polsgrove, 2012). Instead, Alexander (1996: 9) described correct exercise and somatically aware movement as:

“···a general system for the improvement of the entire physical economy by a just co-ordination and control of all the parts of the system, particularly excluding any method which tends to the hypertrophy of any one energy without regard to the balance of the whole.”

Thus, rather than focusing on normative values and fitness parameters, the emphasis should be on the education of the learner’s body, their movement and the “journey” of bodily movement where the emphasis is placed on developing kinaesthetic awareness (Myers, 1998).
3.4.2 Teaching somatic awareness

“Somatic awareness is used, session by session, to increase the patient’s experiential understanding of the connection between bodily symptoms and accompanying thoughts and feelings, and to guide symptom management and wellness through ‘‘letting go’’ and patient-centered self-soothing strategies” (Bakal et al., 2006: 1446).

Somatic awareness techniques are simple and gentle enough to be integrated into everyday life and as a result there is a systemic change in the human being, in amongst other things, the individual’s posture, quality of movement and personality (Alexander, 1985, 1987; Hanna, 1993). There are several ways to teach someone to obtain somatic awareness or to develop the kinaesthetic sense of the self, from passive techniques of Rolfing and acupressure, to active techniques such as Pilates, Yoga, Alexander technique, Bioenergetics and Tai Chi (Loots, 1999). The active techniques utilised in this research incorporate movement and/or visualisation, breathing, meditative awareness and biofeedback training (Bakal et al., 2006).

Somatic techniques are successful because they incorporate a variety of levels of learning modalities as proposed by Myers (1998). It is also important that when teaching somatic awareness or any other technique, that the information is obtained practically and conceptually to match the situation and environment (Field, 2004). Alexander (1985) utilised touch (unconscious learning) and verbal guidance (interconscious learning), while Feldenkrais (1972) and Hanna (1993) incorporated both touch and movement (unconscious learning) with repetition and verbal cues (interconscious learning).

The main method of teaching somatic awareness and developing awareness is achieved through the use of touch (Alexander, 1985, 1996; Myers, 1998) and by the execution of specific movements (Feldenkrais, 1972; Hanna, 2004). Touch is successful in transferring sensory information because it is 30 times faster than visual feedback (which is overused and overrated) and countless times faster than auditory guidance (Myers, 1998). Touch can be used to teach somatic awareness where the practitioner instructs and demonstrates the movement on the patient’s body by touching the various muscle groups and allowing the movement to move through the full range as was prescribed by Alexander (1985), Feldenkrais (1972), Lowen (1975) and Reich (2002).
In addition to touch, specific movements are executed by the learner in a manner that is slow and with concentration in order to experience and sense the greatest amount of feedback. Thus, specific movements may be used to instil improved somatic awareness and develop kinaesthetic awareness as it is done in this research and by bodywork practitioners such as Alexander (1985), Feldenkrais (1972) and Hanna (2004).

3.4.3 From kinaesthetic awareness to kinaesthetic aware motor patterns

Once the new pattern or kinaesthetic memory has been learnt through somatic awareness either with movement or touch (Alexander, 1985, 1987; Feldenkrais, 1972, 2002; Hanna, 1993, 2004), it will have to be repeated (Myers, 1998), practised and executed continuously in order to make it “stable” (Smith & Thelen, 2003). When a movement pattern is executed constantly, as for example, done during exercise of any nature, then there is decreased prefrontal cortex activity (Kemppainen, Aalto, Fujimoto, Kalliokoski, Langsjo, Oikonen, Rinne, Nuutila & Knuuti, 2005; Nybo & Secher, 2004; Tashiro, Itoh, Fujimoto, Fujiwara, Ota, Kubota, Higuchi, Okamura, Ishi, Berecski & Sasaki, 2001) which is an indication that there is increased implicit activation (Section 3.2.5) (Dietrich, 2003, 2006; Dietrich & Audiffren, 2011). When the older and wiser implicit system (Jenkins, Brooks, Nixon, Frackowiak & Passingham, 1994) or the archesoma are allowed to make motor decisions (Hanna, 1993), then there will be a decrease in the inefficient use of the self (Alexander, 1985; Gallwey, 1975; Hanna, 1993, 2004; Feldenkrais, 2002; Lowen, 1975; Lowen & Lowen, 1977).

Once this new kinaesthetic memory is repeatedly executed, there will be a cascade of changes in the entire motor system which results in a newer improved motor solution for the system as a whole (Smith & Thelen, 2003) (Thelen, 1995), because unconscious and interconscious learning takes place (Myers, 1998) and there are physiological and neurological changes. Changes such as training induced plasticity in the neuronal centres (Dietrich & Audiffren, 2011; Dishman et al., 2006; Feldenkrais, 2002; Ivanenko, Poppele & Lacquaniti, 2009) of the CNS and spinal cord, increased neural stimulation and sensory functioning, neurogeneration, neuroadaptation and neuroprotection (Dietrich, 2006; Dietrich & Sparling, 2004; Dishman et al., 2006; Navarro, Vivó & Valero-Cabré, 2007). This indicates that there are long-term functional changes.
The long-term functional physiological changes improve brain function, cognitive performance and even some increases in the grey matter volume in the frontal and superior temporal lobe (Dishman et al., 2006; Stein et al., 2007) through angiogenesis (Dishman et al., 2006; Swain, Harris, Wiener, Dutka, Morris, Theien, Konda, Engberg, Lauterbur & Greenough, 2003), synaptogenesis (Kleim, Barbay, Cooper, Hogg, Reidel, Remple & Nudo, 2002) and neurogenesis (Dishman et al., 2006; Wolf, Melnik & Kempermann, 2011). These physiological changes allow a new pattern to be “stable”, and the older pattern [which may contain SMA (Hanna, 1993)] will not be executed as frequently (Smith & Thelen, 2003). This will allow a new habit to develop and ultimately a behavioural change (Polsgrove, 2008, 2012; Thelen, 1995).

The behavioural change will reflect in one’s quality of movement and be executed repeatedly even in the stress response with rationality, smooth motor control, greater and better coordination, fast, efficient and with real time sensorimotor integration (Alexander, 1985; Barlow, 1990; Cranz, 2000a, 2000b; Dart, 1947; Dietrich & Audiffren, 2011; Feldenkrais, 1972, 2002; Gallwey, 1975; Hanna, 1993, 2004; Loots, 1999; Lowen & Lowen, 1977; Wulf & Prinz, 2001). This change in behaviour will be reflected in the stress response by the development of new stress response patterns and induce adaptations for the stress response, because learning new coherent movement habits cause adaptations to stressors (Lewis & Todd, 2007). The ability to change behavioural patterns also allows one to express the self and the stress response better (Field, 2008; Liddle, Baxter & Gracey, 2004; Myers, 1998; Weerakkody, Percival, Hickey, Morgan, Gregory, Canny & Proske, 2003), which will decrease character armouring (Reich, 2002). Hence, a stressed individual may be taught how to choose and commence with a good movement pattern even in a state of stress (Alexander, 1985; Barlow, 1990; Feldenkrais, 1972, 2002; Loots, 1999).

### 3.4.5 Somatic awareness and the parasympathetic nervous system

Somatic awareness may also be successful in decreasing the chronic stress response manifestations and bring about behavioural changes because it decreases the sympathetic nervous system response to stress by, amongst other things, inducing a parasympathetic state. By improving movement quality and the use of the self there are improvements in breathing and muscle relaxation (Skjaerven et al., 2003), which will naturally induce a parasympathetic state. Muscle relaxation has been found to be successful in reducing stress scores, perceived stress and stress symptoms (Astin et al., 2003; Bakal et al., 2006; Comeaux, 2005; Conrad & Roth, 2007; Cranz, 2000a, 2000b; Engel & Andersen, 2000; Ernst et al., 2007; Feldman, Greeson & Senville,
Breathing is also utilised in various somatic awareness techniques as separate lessons as done by Hanna (1993, 2004), Reich (2002), Feldenkrais (1972, 2002), and integrated into meditation, mind body stress reduction, Yoga and Tai chi (Bertisch et al., 2009). Breathing may also be taught and used to shift an over aroused autonomic and central nervous system to a resting parasympathetic state, and decrease psychological and emotional stressed states (Courtney, 2009; Forman & Myers, 1987; Homma & Masaoka, 2008; Karavidas, Lehrer, Vaschillo, Vaschillo, Marin, Buyske, Malinovsky, Radvanski & Hassett, 2007; Peddicord, 1991). The teaching of breathing has also been shown to improve life (Consolo, Fusner & Staib, 2008; Hagman, Janson & Emtner, 2011), decrease stress (Bell & Saltikov, 2000; Bernardi, Wdowczyk-Szulc, Valenti, Castoldi, Passino, Spadacini & Sleight, 2000; Broadbent, Kahokehr, Booth, Thomas, Windsor, Buchanan, Wheeler, Sammour & Hill, 2012; Consolo et al., 2008; Courtney, 2009; Forman & Myers, 1987; Greenberg, 2006; Hagman et al., 2011; Homma & Masaoka, 2008), decrease anxiety (Chiang, Ma, Huang, Tseng & Hsueh, 2009; Han et al., 1996), decrease muscle tension (Courtney, 2009; Forman & Myers, 1987; Homma & Masaoka, 2008; Karavidas et al., 2007; Peddicord, 1991) and other stress related symptoms (Chiang et al., 2009; Consolo et al., 2008; Hagman et al., 2011; Karavidas et al., 2007; Murthy, Janakiramaiah, Gangadhar & Subbakrishna, 1998).

### 3.4.6 Somatic awareness and flow states

Along with parasympathetic nervous system activation, somatic awareness may also decrease the chronic stress response manifestations by inducing a steady state known as flow (Hunter & Csikszentmihalyi, 2000). The flow experience occurs when one is so involved in an activity with such a high level of concentration in a state of ultimate awareness (Bakker, Oerlemans, Demerouti, Slot & Ali, 2011; Hunter & Csikszentmihalyi, 2000) and effortless attention (Dietrich, 2004a, 2006; Dietrich & Audiffren, 2011; Gallwey, 1975; Hunter & Csikszentmihalyi, 2000; Schuler & Brunner, 2009; Wulf & Prinz, 2001). According to Schuler and Brunner, (2009: 168):
“The involvement in an activity can become so deep that individuals are no longer aware that they are separate from their action and thus it feels as if action and awareness have merged.”

This flow experience is multidirectional (Bakker et al., 2011) and allows an increased flexibility to the whole system so that one can experience insight as Hunter and Csikszentmihalyi (2000: 21) indicated:

“In times of stress, the mind may be too rigid to make the connections necessary for insight to occur. Yet none of this would occur without the ground of a rhythmic, steady experience provided by the body.”

This “steady experience” of flow is the merging of action and awareness and the “insight” is the freedom that the mind experiences when it is not preoccupied with the rigid stress responses. A state of flow is also known as heightened states of consciousness (Dietrich, 2006), and occurs when there is a downregulation of the prefrontal cortex function (explicit narrative self) (Section 3.2.5) and is seen by a decrease in alpha and theta waves of the frontal lobe. Since the hyperactivity of the frontal lobe has been associated with anxiety, depression and stress related disorders (Dietrich, 2006), an upregulation of the embodied implicit self will allow relief from stress and promote brain health (Dietrich, 2006; Dietrich & Sparling, 2004) as one ages (Dishman et al., 2006; Kramer, Erickson & Colcombe, 2006), because of the associated states of egoless-ness, euphoria, calmness, relaxation and bodily integration associated with rhythmical exercise (walking, cycling) (Dietrich, 2003; Dietrich & Sparling, 2004).

Even though complete immersion in rhythmical exercise induces flow states, somatic awareness may be successful because it merges action and awareness. This occurs because somatic awareness techniques apply the same principles one needs to induce flow, such as: whole body movements, clear goals, immediate feedback, inhibition of higher order functions, decreased mental effort, effortless effort, diversion of attention, narrowing of concentration, elimination of worry, failure and self-consciousness (Bakker et al., 2011; Dietrich, 2004a; Dietrich & Audiffren, 2011; Gallwey, 1975; Hunter & Csikszentmihalyi, 2000; Keller, Bless, Blomann & Kleinbohl, 2011; Schuler & Brunner, 2009).

Csikszentmihalyi, 2000; Loots, 2010; Maslow, 1959; Schmidt, 1991; Williamson-Scott, 2007), psychologists (Moran, 2012; Reich, 2002) and sports coaches (Gallwey, 1975) have been using it for many years to decrease mental effort, limit over-thinking, promote high level of performance and effortlessness, optimise movement control, physical motivation, concentration, provide unequivocal feedback, mental well-being (Bakker et al., 2011; Hunter & Csikszentmihalyi, 2000; Schuler & Brunner, 2009) and parasympathetic state induction. This differs substantially to what is the usual belief about movement and effort mechanisms in that one needs increased caloric effort, increased conscious effort and increased perceived exertion (Dietrich & Audiffren, 2011; Schuler & Brunner, 2009). Hunter and Csikszentmihalyi’s (2000: 14) describe this concept in the following way:

“In other words, for a cyclist in flow there is no longer "me and the bike," rather these distinctions become collapsed into a unified sensation of motion. "Me" does not exist; "the bike" does not exist. In essence, the intentionality of this situation has become expanded and extreme. The normal physical boundaries of the body have been transcended and extended to the motion-making tool. So the construction of the world becomes based more on the sensation of movement rather than as a person-on-a-bicycle peddling- quickly-down-the-street. Paradoxically, the sense of self emerges emboldened once the flow experience has subsided. Strengthened with the knowledge of a masterful performance, the self becomes increasingly resilient.”

Thus, one may use somatic awareness to create states of flow through the sensation of movement (Bakal, 2001; Hanna, 1993). Somatic awareness merges the body and the self to create an embodied self (Bloom, 2006), or an embodied archesoma (Hanna, 1993). A fully functional archesoma allows for poised and efficient movement and a stable internal environment so that one may react to the external environment as a system and have an improved stress coping mechanism (Hanna, 1993).

3.5 Conclusion

Somatic awareness is a tool that may be merged into movement to create improved motor patterns and movement solutions. These improved movements then affect the entire kinetic chain positively to reduce chronic stress response patterns through PNS activation, flow and efficient movement execution.
CHAPTER 4

METHODOLOGY

“To understand fully the complexities of many situations, direct participation in and observation of the phenomenon of interest may be the best research method” (Patton, 1990: 25).

4.1 Introduction

The aim of the study was to compare from a Biokinetic perspective, the efficacy of two exercise protocols on the stress response in individuals identified with chronic stress. This was achieved by investigating the effects of somatic and aerobic exercise, as well as the combination of the two on individuals who are identified as stressed through utilisation of subjective and objective measures.

4.2 Research design

The present investigation made use of a quantitative, comparative experimental research design over an eight-week period using pre- and post-tests. Table 4.1 provides a summary of the methodological framework of the study.

4.3 Subjects

Participants were recruited from working environments in the Johannesburg area, through distribution of information brochures to banks, corporate companies, law firms, small businesses and accounting firms.

In the initial screening, volunteers were asked to complete an informed consent (Appendix A), a stress questionnaire (Appendix B), a medical screening form (Appendix C) and demographical data such as age, gender and race. Smoking habits were also taken into account in order to obtain more information about the sample for later comparison. This took approximately 10 minutes to complete.
Table 4.1: Methodological framework of the present study

<table>
<thead>
<tr>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>102 Participants</td>
</tr>
<tr>
<td>Ranked as moderately to highly stressed from the Johannesburg area</td>
</tr>
<tr>
<td>Age ranked from 18 to 65</td>
</tr>
<tr>
<td>Subjects met inclusion criteria</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrospective health questionnaires and informed consent</td>
</tr>
<tr>
<td>Psychological Screening: Stress Score</td>
</tr>
<tr>
<td>Physical/ Biokinetic Assessment:</td>
</tr>
<tr>
<td>Anthropometrical measurements of body height and body mass</td>
</tr>
<tr>
<td>Cardiovascular parameters of resting blood pressure and resting heart rate</td>
</tr>
<tr>
<td>Body sway</td>
</tr>
</tbody>
</table>

Subjects not exercising prior to study randomly assigned into 4 groups
Exercising subjects were assigned to an exercise group

<table>
<thead>
<tr>
<th>Intervention Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1: Aerobic</strong></td>
</tr>
<tr>
<td><strong>Warm up:</strong></td>
</tr>
<tr>
<td>Duration: 5-10 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Exercises:</strong></td>
</tr>
<tr>
<td>Type: Aerobic</td>
</tr>
<tr>
<td>Duration: 20-30 minutes</td>
</tr>
<tr>
<td>Intensity: Borg scale 10-12</td>
</tr>
<tr>
<td><strong>Cool down:</strong></td>
</tr>
<tr>
<td>Duration: 5 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Group 2: Somatic</strong></td>
</tr>
<tr>
<td><strong>Warm up:</strong></td>
</tr>
<tr>
<td>Duration: 5-10 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Exercises:</strong></td>
</tr>
<tr>
<td>Type: No aerobic exercise prescribed</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>Somatic awareness exercises (Lessons 1-8)</td>
</tr>
<tr>
<td><strong>Cool down:</strong></td>
</tr>
<tr>
<td>Duration: 5 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Group 3: Combination</strong></td>
</tr>
<tr>
<td><strong>Warm up:</strong></td>
</tr>
<tr>
<td>Duration: 5-10 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Exercises:</strong></td>
</tr>
<tr>
<td>Type: Aerobic</td>
</tr>
<tr>
<td>Duration: 20-30 minutes</td>
</tr>
<tr>
<td>Intensity: Borg scale 10-12</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>Somatic awareness exercises (Lessons 1-8)</td>
</tr>
<tr>
<td><strong>Cool down:</strong></td>
</tr>
<tr>
<td>Duration: 5 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Group 4: Exercise</strong></td>
</tr>
<tr>
<td><strong>Warm up:</strong></td>
</tr>
<tr>
<td>Duration: 5-10 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Exercises:</strong></td>
</tr>
<tr>
<td>Continue with present exercise programme</td>
</tr>
<tr>
<td>AND</td>
</tr>
<tr>
<td>Somatic awareness exercises (Lessons 1-8)</td>
</tr>
<tr>
<td><strong>Cool down:</strong></td>
</tr>
<tr>
<td>Duration: 5 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Group 5: Control group</strong></td>
</tr>
<tr>
<td><strong>Warm up:</strong></td>
</tr>
<tr>
<td>Duration: 5-10 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
<tr>
<td><strong>Exercises:</strong></td>
</tr>
<tr>
<td>No exercise</td>
</tr>
<tr>
<td><strong>Cool down:</strong></td>
</tr>
<tr>
<td>Duration: 5 minutes</td>
</tr>
<tr>
<td>Intensity: Borg Scale of 5-8</td>
</tr>
</tbody>
</table>

**Post-test**

Stress Score
Resting blood pressure
Resting heart rate
Anthropometric measurements of height and weight
Body sway

**Statistics**

Descriptive statistics
One-way ANOVA
Post Hoc comparisons
Paired sample T-test
Effect size
Once the medical screening forms and stress questionnaires were completed the subjects were screened for exclusion criteria. If participants had any of the exclusion criteria listed in Table 4.2 and seen in Figure 4.1, they were immediately excluded from the study. The relative and absolute contraindications to exercise are found in Appendix E. Inclusion criteria included the absence of exclusion criteria, participants who are physically able and a stress score higher than 10.

Table 4.2: The exclusion criteria for elimination of participants in the study (modified from American College of Sports Medicine, 2006; Heyward, 2006; also see Figure 4.1)

<table>
<thead>
<tr>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress score &lt;10</td>
</tr>
<tr>
<td>Pregnancy</td>
</tr>
<tr>
<td>Acute Illness</td>
</tr>
<tr>
<td>Chronic Illness</td>
</tr>
<tr>
<td>Cardiac Risk</td>
</tr>
<tr>
<td>Relative contraindications to exercise</td>
</tr>
<tr>
<td>Absolute contraindication to exercise</td>
</tr>
</tbody>
</table>

Originally the statistical requirement was to select 80 participants for inclusion in the study. After screening, 102 individuals indicated their willingness to participate in the present study, 82 of which did not partake in exercise six months prior to the study and 20 who did partake in exercise six months prior to the study (Figure 4.1). Those selected for participation in the study were randomly assigned into four different groups (Figure 4.1). Figure 4.1 provides a summary of the random assignment of the participants into the relevant groups. Participants, who had not participated in exercise six months prior to the study, were randomly placed in either control, aerobic, combination or somatics awareness groups. Those who had exercised in the six months prior to the study were all allocated to an one exercise group.
Figure 4.1: The initial number of participants in the study and the random assignment of participants into the relevant groups

Of the original 102 subjects 46 were excluded during the study for various reasons: 29 dropped out prior to the study because of inability to commit, two failed to complete the study, two did not complete the exercise programmes due to time constraints and 13 failed to attend the post-test due to work obligations and time constraints. At the end, this left a total of 56 participants in the study (Figure 4.2).

Figure 4.2: The final number of participants in each group who fully participated in the present study
4.4 Research instruments and method of assessment

Stress is pluricausal (Selye, 1976 and previous chapters), thus it is not advisable to use a single test to identify and reflect stress. Consequently, a battery of tests was used in this study; the overview of the tests was then used as a reliable indicator of the non-specific responses of the stress response which can reflect the level of stress someone is experiencing (Everly & Lating, 2002). The assessment tools utilised include: scales for measurement of the cognitive-appraisal and psychological assessment (Everly & Lating, 2002) (Figure 2.6 Step 2); cardiovascular indices and a physical examination which measures the stress response and target organ activation (Everly & Lating, 2002) (Figure 2.6 Step 4 and Step 5, Section 2.3).

4.4.1 Psychological screening

Psychological screening is usually carried out by measuring subjective appraisal of psychogenic stress, through the use of a questionnaire or a scale (Matthews, 2000; Selye, 1976). This is because the stress response will only be elicited if the stressor is deemed relevant by the cognitive-affective domain. In this case, the “Perceived Stress Scale” was selected (Appendix B) because it is the most reliable and valid of the tests available for subjective appraisal as shown by Cohen, Kamarck and Mermelstien (1983) and has been used for physical and mental health in previous studies (Cohen, 2000). The reliability score using Cronbach’s alpha was recently reported as 0.72 in Benham (2006: 1435). This method is also user friendly, brief, simple to understand (Cohen, 2000), cost-effective, and a practical and efficient way to measure the stress response indirectly (Everly & Lating, 2002). It takes into account the degree that a person will perceive his/her life as stressful and how much stress is present in his/her life, rather than just measuring the response to a specific stressor (Cohen, 2000). The “Perceived Stress Scale” has 10 items with a score that ranges from 0 to 40, the associated stress level with each stress score is shown in Table 4.3. Thus, if an individual is ranked below 10 points then they are experiencing minimal stress.

<table>
<thead>
<tr>
<th>Stress Score</th>
<th>&lt; 10</th>
<th>10-20</th>
<th>20</th>
<th>20-30</th>
<th>30-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress Level</td>
<td>Low</td>
<td>Moderate</td>
<td>Average</td>
<td>High</td>
<td>Very High</td>
</tr>
</tbody>
</table>

Table 4.3 The perceived stress scale norms for classification of stress levels (modified from Cohen et al., 1983)
4.4.2 Biokinetic assessment

After assignment into groups (Section 4.3), all the participants underwent the physical pre-assessment, which took approximately 20 minutes to complete (see Table 4.5). The initial pre-test of participants in the study was done under the supervision of the present author who is a qualified Biokineticist. The subjects were advised not to ingest any caffeinated drinks 12 hours prior to the testing (Lane, Adock, Williams & Kuhn, 1990) (caffeine has the ability to alter neuroendocrine and cardiovascular stress reactivity) and not to smoke 12 hours prior to the testing (since smoking excites the sympathetic nervous system) (Narkiewicz, van de Borne, Hausberg, Cooley, Winniford, Davison & Somers, 1998).

The physical assessment included several measurements that are applicable to the Biokinetic profession and that measure a wide-range of physiological reactions associated with the stress response. The reason for using more than one test is that increased amounts of reasonable data can be gathered from taking a wide-range of physiological reactions rather than taking one alone (Dunbar, 1943). The physical parameters measured were: anthropometric measurements (body height and body mass), cardiovascular measures (heart rate and blood pressure) and body sway.

4.4.2.1 Anthropometrical measurements

4.4.2.1.1 Body height

Body height was measured in centimetres (cm) to the nearest 0.1 cm using a standard stature meter (Panamedic, Korea). The volunteers were instructed to stand barefoot against a wall, with heels together and their buttocks and scapulae against the wall. Their heads were then positioned in the Frankfort plane (Norton & Olds, 2004). The base of the height meter was lowered and height measured. Measurements were taken twice to ensure accuracy (Barroso, Arezes, da Costa & Miguel, 2005).

4.4.2.1.2 Body mass

Mass was measured to the nearest 0.5 kilogram (kg) using a body mass scale (Personal Scale, Beurer, Germany) of maximum measurable weight of 150 kg. The volunteers were instructed to stand barefoot in minimal clothing on the scale, with both feet evenly on and looking straight
ahead (Norton & Olds, 2004). Measurements were taken twice to ensure accuracy (Barroso et al., 2005).

4.4.2.2 Cardiovascular parameters

4.4.2.2.1 Resting blood pressure

Blood pressure was measured using a stethoscope and a standard Mercury sphygmomanometer (Basak & Karazaybek, 1999) since it is a popular, reliable and valid manner to measure blood pressure (Xuegang, 2010). The protocol was followed as per the recommendations of the American College of Sports Medicine (ACSM, 2006: 43): the participants were seated in a quiet room for at least 5 minutes with their left arm resting on a table so that the middle of the arm was at the level of the heart and their feet flat on the floor. The first and last Korotkoff sounds were used to determine systolic and diastolic blood pressure, respectively. Two readings were taken at least a minute apart to ensure accuracy (ACSM; 2006: 43).

4.4.2.2.2 Resting heart rate

Heart rate was determined by radial artery palpation. The first and second fingers were placed over the radial artery on the left side of the body; this is found near the thumb side of the wrist. Once the pulse was located it was counted for 15 seconds using a stop watch. The value was then multiplied by four. This reading was then repeated to ensure accuracy (ACSM, 2006: 76).

4.4.2.3 Body sway assessment

Body sway relates to the dynamic equilibrium of the body where standing still produces movements forward, backwards and sideways. These movements create oscillations throughout the body. The intensity and frequency of the oscillations change according to the ability of the body to maintain an erect posture against the forces opposing it (Ratliffe, Alba, Halium & Jewell, 1987) such as gravity. Since the human body is a dynamic structure, it is difficult to maintain a body sway of zero (no movement) because of physiological functions such as respiration, heart beat and blood flow (Hunter & Kearney, 1981; Schmid, Conforto, Bibbo & D’Alessio, 2004).
In the present study, electronic and technological equipment were employed to measure body sway, which can be used as a physical indicator of stress (Balaban & Thayer, 2001; Loots, 1999). As explained previously (Section 2.3.5.1.1), stress alters the function of these pathways and therefore can affect body sway and balance (Balaban & Thayer, 2001). For a more detailed discussion see Balaban and Thayer (2001).

Body sway data was obtained by the use of the Nintendo WiiMote (Nintendo Wii Remote), since this was the first time it has been used in research, there is limited knowledge of the reliability and validity of the Nintendo WiiMote for body sway. However, other studies have effectively used motion sensor technology and accelerometers to assess and monitor body sway (Yang & Hsu, 2010; Zheng, Black & Harris, 2005), and the Nintendo WiiMote is successful in tracking position and obtaining motion data (Modrono, Rodríguez-Hernández, Marcano, Navarrete, Burunat, Ferrer, Monserrat & González-Mora, 2011; Sathyaranayanan, Pallavaram, Bodenheimer, Robinson, Dawant & Davis, 2007; Shih, Chang & Shih, 2010).

The WiiMote contains three accelerometers which measures forces in three dimensions; and vibration and motion sensors. The motion sensor was attached to the individual using an elasticised band and placed on the thoracic spine, from the 9th thoracic vertebrae to the 12th thoracic vertebrae (T9-T12). The individual was instructed to stand barefoot and stare at a spot on the wall while keeping still for 30 seconds. The Nintendo WiiMote software programme was then initiated and the coordinates were recorded and stored on a lap top computer’s hard-drive. After 30 seconds the sensor is switched off, the results saved and the test was run again. The motion sensor data was then transmitted to the computer via Bluetooth wireless communication system. The data was interpreted by GlovePIE software and translated into key strokes. GlovePIE contains scripts which are used to run the software and interpret the data (Design Engineering Office, 2006). The data is then exported into Microsoft Excel where data is arranged into columns with the variables: X and Y.

The WiiMote has many calibrated values, for the purposes of the present study Real Acceleration X and Y coordinates were used for statistical purposes. These values are the real acceleration value with the force of gravity eliminated (Design Engineering Office, 2006). These acceleration values were therefore relative to the WiiMote’s orientation, in other words the X coordinate indicates an anterior-posterior movement and the Y coordinate indicates a medial-lateral movement (Design Engineering Office, 2006). Also, if the X value was negative the movement was left, and if the X coordinate was positive the movement was right (Table 4.4).
For the purpose of the research one would determine an improvement in body sway if the coordinates from the pre-test to the post-test results were closer to zero, if the sway pattern was more linear and smaller in area in both the X and Y coordinate.

Table 4.4: The coordination values for the WiiMote and direction of movement (modified from Design Engineering Office, 2006)

<table>
<thead>
<tr>
<th>Coordinate</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>+</td>
<td>—</td>
</tr>
<tr>
<td>Direction</td>
<td>Right</td>
<td>Left</td>
</tr>
</tbody>
</table>

4.5 The intervention protocol

Upon completion of the Biokinetic screening the four randomly selected groups (somatic, aerobic, combination and exercise group), were given their respective exercises indicated in Table 4.5. The exercise intervention for each group is shown in Table 4.5, intervention 1 is the aerobic exercise (Section 4.5.2.2) and stretching (Section 4.5.2.4) and intervention 2 is somatic exercise (Section 4.5.2.5). It is to be noted that the control group did not receive any of the above mentioned, but were instructed to continue with their life as usual (Section 4.5.2.6). All groups had to complete the pre-test before commencement of the research and after the eight-week period the post-test.

Table 4.5: The five groups and their respective interventions

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Intervention 1: Aerobic Exercise</th>
<th>Intervention 2: Somatic Awareness Exercise</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Aerobic</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Somatic</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Combination</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Control</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
4.5.1 The number of sessions

Participation in a chronic exercise programme has been shown to provide the best physical and psychological health benefits and acts as a buffer against stress (Cox, 2002). Thus, an eight-week intervention has been chosen for the purpose of this study. All groups were told that they had to participate in the study for eight-weeks, and participation in the given intervention was a minimum of three times a week and a maximum of six times a week (ACSM, 2006). This totals a required number of 24 exercise sessions over the eight-week period. Volunteers were allowed to exercise at a time that suited them, because there is no marked difference in stress levels that is dependent on the time that one exercises (Cox, 2002).

4.5.2 Intervention: Exercise session breakdown

The exercise sessions for each group were assigned as shown in Table 4.5. The interventions were composed of three types of exercise, namely Aerobic, Stretching and Somatic Awareness. Each group thus had a different set of exercises. The exercises were given to each participant on a DVD, which was used to explain the intervention using audio and visual instructions (Appendix G).

The aerobic group DVD contained aerobic exercise and stretching, the somatic group DVD only had somatic exercises, the combination group DVD included aerobic, stretching and somatic exercise and the exercise group DVD included participation in the exercise of their choice with the addition of somatic exercise. The control group was not issued with a DVD since they had no intervention. All the groups except the control and somatic group had a warm up and a cool down included. The specific breakdown of each modality will be described in the proceeding paragraphs.

4.5.2.1 Warm-up

A warm up routine was provided in order to facilitate the transition between a state of rest to a state of physical exertion (ACSM, 2006; Baechle & Earle, 2000; Powers & Howley, 1997). The use of a warm-up is important for prevention of injury, to prepare for physical exertion (ACSM, 2006; Baechle & Earle, 2000; Powers & Howley, 1997) and for psychological arousal (Heyward, 1997; Powers & Howley, 1997). The warm-up was to be done using a cardiovascular modality, for 5-10 minutes at a low intensity (ACSM, 2006). The intensity should be lower than that of the
aerobic activity chosen, preferably on a Borg Scale of 5-8 (Baechle, & Earle, 2000) (Appendix F).

4.5.2.2 Aerobic exercise

It is suggested that moderate aerobic intensity provides stress relief (Cox, 2002), so the volunteers performed aerobic exercise at a moderate level of intensity for 20-30 minutes (ACSM, 2006; Bond et al., 2002; Cox, 2002). This, on a Borg Scale for Rating of Perceived Exertion, is between 10 and 12 (Baechle, & Earle, 2000) (Appendix F). The mode of aerobic exercise is irrelevant since no difference has been noted between the various modes of aerobic modalities (e.g. walking vs. stepping). Thus, the volunteers were allowed to participate in walking, rowing, cycling, elliptical training, swimming, recumbent cycling and stepping.

4.5.2.3 Cool down

The cool down was done after the aerobic exercise session, using a cardiovascular modality for 5 minutes at a low intensity level (ACSM, 2006). The use of the cool down is to recover from exercise, allow the heart rate and blood pressure to return to resting levels, prevent blood pooling, post exercise hypotension and increments in plasma catecholamine levels (ACSM, 2006; Beachle & Earle, 2000; Heyward, 2006).

4.5.2.4 Stretching exercise

Stretching was performed after the cool down and was chosen because stretching has been shown to decrease the stress response and induce a physiological as well as a psychological relaxation response (Bond et al., 2002; Cox, 2002; Quick et al., 1997). The stretches concentrated on stretching gross musculature over the whole body and were completed in 15 minutes. The stretching instructions and guidelines (ACSM, 2006; Beachle & Earle, 2000; Heyward, 2006) were discussed with and demonstrated to the subjects, with emphasis on correct breathing, limb placement and the range of motion.

The type of stretching chosen was static, where the muscle and tendon would be held in a static position for 30 seconds and repeated three times (ACSM, 2006). The stretches include the following musculature:
• Hamstring (supine single leg flexion) (Kendall, McCreary, Provance, Rodgers & Romani, 2005: 390).
• Neural hamstring (supine single leg flexion with foot dorsiflexion) (Kendall et al, 2005: 390).
• Quadriceps (side lying knee flexion) (Heyward, 2006: 358).
• Hip flexors (kneeling lunge stretch) (Anderson et al., 2005: 273).
• Trunk extensors (cross over stretch) (Anderson et al., 2005: 273).
• Calves (standing leg extension and foot dorsiflexion) (Anderson et al., 2005: 565; Heyward, 2006: 363).
• Triceps (cross over arm stretch) (Baechle & Earle, 2000: 334) and
• Neck (seated neck leans) (Kendall et al, 2005: 163).

4.5.2.5 Somatic awareness exercises

Somatic exercises were included in the programmes of the somatic and the combination groups. The use of somatic awareness exercises included in the present study was to determine if the use of these exercises could lead to a change in the physiological and psychological tested parameters.

The somatic awareness programme was designed by making use of various sources such as the Mitzvah exercise (Cohen-Nehemia, 1983; Cohen-Nehemia & Clinch, 1982) and other somatic-awareness exercises namely those of Feldenkrais (1972), Hanna (1988), Lowen and Lowen (1977) and Williamson-Scott (2007). However, the main body of work and the structure of the lessons were taken from Hanna (2004). These exercises (somatic awareness) work on the basis of increasing somatic awareness in the individual by teaching correct movement of various parts of the body through movement of the body. This then increases the ability of subjects to become aware of their own movements and posture and make appropriate corrections where and when required. The movements are slow and gentle and they focus on correct movement and placement (Hanna, 1988). The lessons were done a minimum of three times a week.
The sessions were divided into eight lessons, and each lesson focused on increasing the awareness and releasing muscle tension in a particular group of muscles:

- **Lesson 1: Extensor back muscles.** This lesson focuses on increasing the awareness of the lower back muscles and on decreasing lumbar extensor tension by increasing the movement in the hips.

- **Lesson 2: Flexor muscles of stomach.** Here the lesson builds on Lesson 1 where the back extensors are integrated with the abdominal and anterior musculature. The participant is taught to integrate the muscles and the movements using the hip muscles and allowing for the agonists and antagonists to work together.

- **Lesson 3: Muscles of the waist.** This lesson concentrates on the waist muscles such as the internal and external obliques as well as the quadratus lumborum. The point of the lesson is to increase the muscle length at the waist and decrease the feeling of tightness in the obliques and the quadratus lumborum.

- **Lesson 4: Controlling muscles involved in trunk rotation.** This lesson takes advantage of the growing sensitivity and control attained in Lessons 1-3. The main movements are rotational movements of the trunk muscles (quadratus lumborum, abdominals, back extensors), with attention given to the elongation and awareness on the function of the trunk muscles.

- **Lesson 5: Hip and leg muscles.** In this lesson the participant is taught how to free the muscles of the trunk, hips, legs and feet. The basics of locomotion are analysed and the freeing up of movement along the entire lower body.

- **Lesson 6: Neck and shoulders.** This lesson focuses on increasing the awareness of the upper body, freeing up the ribs, chest, shoulders and neck and increasing the movements of the upper body.

- **Lesson 7: Breathing.** The focus of this lesson is on breathing, specifically breathing done with the diaphragm (based on the work of Reich (1973)).

- **Lesson 8: Walking.** This lesson now builds on what has been achieved in Lessons 1-7. It teaches walking with proper trunk, spinal and shoulder rotation as well as the rotation experienced by the arms and legs. It emphasises the contra lateral walking pattern, and on making walking effortless and graceful.
4.5.2.6 Control group

Participants assigned to the control group were instructed to continue with their daily activities, but not to take part in any physical activities for the eight-week research period. Therefore, they had to maintain their lifestyle patterns of smoking, alcohol intake, diet, sleep pattern, daily tasks and work commitments. The control group also completed the same forms and the pre- and post-tests.

4.5.3 Participant compliance and supervision

The participants were not supervised as they had been taught to do the exercises in the pre-test session and the DVD provided all the necessary information. Volunteers were also instructed to contact the main researcher should there be a misunderstanding concerning the given exercise programme.

Participant compliance was monitored with weekly phone calls and emails, where it provided a reminder to continue with the programme and determined if the participants were completing the required number of exercise sessions. In order to measure participant compliance, an exercise diary (Appendix D) was issued to each participant in the pre-test. The diary was used to record the exercise session, duration, date and overall mood (Burgio, Locher, Goode, Hardin, McDowell, Dombrowski & Candib, 1998; Lutz, Stults-Kolehmainen & Bartholomew, 2010; Morin, Colecchi, Stone, Sood & Brink, 1999; Stone, Shiffman, Schwartz, Broderick & Hufford, 2003).

4.6 Ethical considerations

The present study was granted ethical approval by the Ethical Committee of the University of Johannesburg prior to its commencement. A letter of information (Appendix A), a stress questionnaire (Appendix B) and a medical screening form (Appendix C) were issued to each participant. The letter of information included an informed consent form and the following information was also supplied: The Right to Privacy, Confidentiality and Anonymity; The Right to Equality, Justice, Human Dignity and Protection Against Harm; The Right to Freedom of Choice, Expression and Access to Information and the Rights of the General Community and Scientific Community.
4.7 Data analysis

The data collected over the eight-week period was analysed by the University of Johannesburg’s statistical consultation services (STATKON). Various statistical tests were conducted including descriptives to analyse normality and skewness and kurtosis, one-way Analysis of Variance (ANOVA) to test for statistical significance between groups, Post Hoc comparisons, paired sample T-test to test for pre- and post-test statistical differences. Effect size was also used to note the size of the effect that the intervention had.
CHAPTER 5

RESULTS

The purpose of the current investigation was to determine if aerobic and somatic awareness exercise would decrease the detrimental effects of subjective and objective stress. Recorded values included perceived stress from the stress score, systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (RHR) and body sway. This chapter will include the data analysis of the results of the present study and briefly elaborate on the efficacy of the aerobic and somatic awareness exercises on the above mentioned physiological parameters and perceived stress score, in order to determine their impact on stress.

5.1 Demographics of the total sample

Demographical data such as age, sex, race and smoking were collected in order to account for comparison of internal variables. The sample consisted of 56 participants with a mean age of 41.02 (SD = 10.69) and a range between 22-65 years. The mean age of this sample is indicative of an older population in the corporate environments in the Johannesburg area. Demographics of the total sample (n = 56) is outlined in Table 5.1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sub-Variable</th>
<th>Number of participants (n = 56)</th>
<th>Number of participants expressed in percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Males</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>Race</td>
<td>Black</td>
<td>12</td>
<td>21.4</td>
</tr>
<tr>
<td></td>
<td>Indian</td>
<td>5</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>39</td>
<td>69.6</td>
</tr>
<tr>
<td>Smoking</td>
<td>Smokers</td>
<td>15</td>
<td>26.8</td>
</tr>
<tr>
<td></td>
<td>Non-smokers</td>
<td>41</td>
<td>73.2</td>
</tr>
</tbody>
</table>
The total sample comprised of 42 females (75%) and 14 males (25%). The reason for this remains unclear since some studies found males avoided exercise-based intervention (Chinn, White, Howel, Harland & Drinkwater, 2006), while others found that females tend to avoid research participation (Barsdorf & Wassenaar, 2005; Brown & Topcu, 2003; Creel, Losina, Mandl, Marx, Mohamed, Martin, Martin, Millett, Fossel & Katz, 2005). Some studies, on the other hand, suggest that females are more stressed than males (American Psychological Association, 2012), and females may be more willing to participate in research if they knew the reasons for doing so, and are also more willing to improve their health (Ellis, Butow, Tattersall, Dunn & Houssami, 2001). Since a detailed explanation of the study was given to all the subjects prior to participation, this may account for the increased female demographic as well as their willingness to improve their stress levels. Another reason for the increased female participation may be due to the distribution of females in the entry level and middle management corporate positions in South Africa. The researcher was only allowed access to entry level and middle management corporate staff and a South African study found that South African females are usually found in entry level and middle management positions, whereas men are found in higher level positions (Mathur-Helm, 2005).

The ethnicity of the total sample consisted of white (n = 39; 69.6%), Indian (n = 5; 8.9%) and black participants (n = 12; 21.4%), indicating that there is a greater white participation in the study. This may be because the black population in South Africa avoid physical activity (Hamer, Malan, Schutte, Huisman, van Rooyen, Schutte, Fourie, Malan & Seedat, 2011; Walker, 1995; Walker et al., 2001) and minorities such as the Indian population avoid research participation (Dunlop, Leroy, Logue, Glanz & Dunlop, 2011; Wendler, Kington, Madans, van Wye, Christ-Schmidt, Pratt, Brawley, Gross & Emanuel, 2006; Williams et al., 2008). If one does not partake in formal exercise, one is unlikely to want to participate in research of a physical nature.

As far as smoking status is concerned 15 (26.8%) participants smoked, while 41 (73.2%) participants did not smoke. The majority of the sample was non-smokers, as smokers are less willing to participate in research studies especially if they involve exercise interventions (Chinn et al., 2006).

In addition to the demographics, pre-test subjective and objective measures of stress score, body height, body mass, resting systolic blood pressure (Pre SBP), resting diastolic blood pressure (Pre DBP) and resting heart rate (Pre RHR) were analysed. The final data analysis for these values is shown in Table 5.2.
Table 5.2: Pre-test subjective and objective data for the total sample (n = 56)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Stress Score</td>
<td>21.55</td>
<td>5.72</td>
</tr>
<tr>
<td>Body Height (cm)</td>
<td>164.59</td>
<td>8.14</td>
</tr>
<tr>
<td>Body Mass (kg)</td>
<td>74.85</td>
<td>18.95</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>124.66</td>
<td>16.53</td>
</tr>
<tr>
<td>Diastolic Blood Pressure (mmHg)</td>
<td>80.46</td>
<td>11.41</td>
</tr>
<tr>
<td>Heart Rate (bpm)</td>
<td>74.79</td>
<td>11.22</td>
</tr>
</tbody>
</table>

The stress score for the total sample (n = 56) had a mean of 21.55; SD = 5.71 and a range of 10-33. The number of stressed participants were categorised according to Table 4.3 and further analysis indicated that there were 1.79% (n = 1) with low levels of stress, 33.93% (n = 19) that were moderately stressed, 7.14% (n = 4) whose stress levels were average, 26.43% (n = 26) with high levels of stress and 10.7% (n = 6) with very high levels of stress. This is an indication that the majority of participants were suffering from moderate to high stress and were thus suitable to be included in the study. Carlson et al. (2007) found this to be an appropriate population for psychosocial group research in which an intervention is to be used, rather than to use extremes of high or low stress levels only.

The body height of the sample has a mean value of 164.59 cm (SD = 8.14) and ranged from 146 to 186 cm. Males had a mean body height of 176.0 cm and females a mean of 161.9 cm. South African normative values for height data were found to be 1.69 cm for males and 1.58 cm for females (Puoane, Steyn, Bradshaw, Laubscher, Fourie, Lambert & Mbananga, 2002). Although there is a slight difference in height values, the values obtained from the present study compare relatively well with the normative body height values for a South African population.

Mean body mass values for the total sample (n = 56) was 74.85 kg (SD = 18.95) with a range of 44.0-154.0. The mean body mass of the males was 92.77 kg and the mean body mass of the female mean values was 70.91 kg. Puone et al. (2002) found normative values for males of 65.2 kg and 67.8 kg for females. This indicates that on average, the present study’s participants were overweight in comparison to South African norms.
Blood pressure mean values include systolic and diastolic measurements, and were found to be 124.66 mmHg (SD = 16.53) with a range of 100-172 mmHg for systolic blood pressure and 80.46 mmHg (SD = 11.41) with a range of 60-120 mmHg for diastolic blood pressure. Healthy normal blood pressure values are 120/80 mmHg (ACSM, 2006; Martini, 2006: 734). These results indicate that blood pressure in this sample ranged from normal to high. The increased blood pressure values may, amongst other things, be due to exposure to chronic stress (Selye, 1976).

The mean resting heart rate value for the present study was 74.79 bpm (SD = 11.22) with a heart rate range of 54-110 bpm. Average heart rate values for a non-sporting population is between 60-100 bpm (ACSM, 2006: 280).

Upon completion of the data analysis, it can be concluded that the participants were experiencing moderate to high levels of stress and the elevated blood pressure and heart rate responses may also be an indicator thereof. Due to the sample’s demographics, the results are also biased towards white, older females who are overweight. In the next section, the results of the inferential statistics will be examined.

5.2 Pre- and post-test within group differences

Before commencing with pre- and post-test data differences, statistical tests such as the ANOVA and Post Hoc comparisons using Dunnett T3 were done in order to eliminate possible errors between groups (Pallant, 2007). There were no statistically significant differences between groups at the pre-test, indicating that all the groups were homogenous as far as subjective and objective measures were concerned prior to the intervention.

Pre- and post-test within group differences were determined by comparing the post-test data to pre-test data within each group. A paired sample t-test was used to evaluate the impact of the intervention on the subjective stress score and the physiological stress variables. The statistically significant values are highlighted in each table in red.
5.2.1 Perceived stress

The aim of the perceived stress questionnaire is to obtain information pertaining to the psychological subjective experience of stress of subjects (Cohen, 2000). The results from the paired sample t-test data analysis is shown in Table 5.3 and the results that were found to be statistically significant are highlighted. It can be seen that there was a statistically significant decrease (p < 0.05) in the stress scores from the pre-test to the post-test in all the groups except the control group.

Table 5.3: Mean stress scores from the perceived stress scale for all five groups from pre-test to post-test

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Mean difference</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Aerobic</td>
<td>18.80</td>
<td>5.60</td>
<td>14.20</td>
<td>6.64</td>
</tr>
<tr>
<td>Somatic</td>
<td>24.11</td>
<td>3.44</td>
<td>15.44</td>
<td>5.46</td>
</tr>
<tr>
<td>Combination</td>
<td>23.38</td>
<td>6.35</td>
<td>16.63</td>
<td>3.62</td>
</tr>
<tr>
<td>Exercise</td>
<td>25.44</td>
<td>4.04</td>
<td>18.33</td>
<td>5.17</td>
</tr>
<tr>
<td>Control</td>
<td>19.47</td>
<td>5.68</td>
<td>18.87</td>
<td>5.83</td>
</tr>
</tbody>
</table>

5.2.1.1 The Aerobic group

In the perceived stress score a significant decrease of 4.60 (p = 0.02) was found between the pre-test and the post-test in this group (Table 5.3). The eta squared statistic (0.33) indicated a medium effect size (Cohen, 1988).

5.2.1.2 The Somatic group

A significant decrease of 8.67 was found in the perceived stress score of the somatic group (p = 0.00) (Table 5.3) from pre-test to post-test. The eta squared statistic (0.76) indicated a large effect size (Cohen, 1988).
5.2.1.3 The Combination group

The mean decrease from the pre-test to the post-test in stress score of this group was 6.75 and was found to be statistically significant (p = 0.00). The eta squared statistic (0.76) indicated a large effect size (Cohen, 1988).

5.2.1.4 The Exercise group

Stress scores decreased from pre-test to post-test by 7.11 (p = 0.00) in the exercise group (Table 5.3). The eta squared statistic (0.75) indicated a large effect size (Cohen, 1988).

When comparing the mean differences between the pre- and post-test scores, the somatic group, the exercise group and the combination group all had large affect sizes and mean differences of -8.67, -7.11 and -6.75 respectively. In this case, the somatic awareness group had the greatest stress score decrement, which could suggest that it is the most effective in decreasing perceived stress in this study.

Along with subjective perceived stress, objective indicators of stress were also investigated in the present study. This will be discussed in the following section.

5.2.2 Measurement of objective stress

Objective measurements of stress include cardiovascular parameters such as blood pressure and heart rate, and body sway measurements.

5.2.2.1 Systolic blood pressure

Systolic blood pressure values obtained during the pre-test and post-test are shown in Table 5.4. The only group which had a statistically significant change from pre-test to post-test was the somatic awareness group. The mean decrease in systolic blood pressure in this group was 8.33 mmHg (p = 0.00), which was greater than the systolic blood pressure decrease of 6.4 mm Hg (p = 0.17) in aerobic group (Table 5.4). The eta squared statistic of 0.81 indicated a large effect size (Cohen, 1988), suggesting that the somatic awareness exercise was effective in decreasing systolic blood pressure in moderately to highly stressed individuals.
Table 5.4: Mean resting systolic blood pressure values from pre-test to post-test for the five groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Aerobic</td>
<td>133.27</td>
<td>20.34</td>
<td>126.87</td>
<td>21.12</td>
<td>0.17</td>
</tr>
<tr>
<td>Somatic</td>
<td>127.33</td>
<td>12.08</td>
<td>119.00</td>
<td>11.47</td>
<td>0.00</td>
</tr>
<tr>
<td>Combination</td>
<td>115.00</td>
<td>11.76</td>
<td>104.00</td>
<td>13.82</td>
<td>0.16</td>
</tr>
<tr>
<td>Exercise</td>
<td>117.89</td>
<td>12.82</td>
<td>114.22</td>
<td>10.32</td>
<td>0.23</td>
</tr>
<tr>
<td>Control</td>
<td>123.67</td>
<td>15.65</td>
<td>124.60</td>
<td>16.89</td>
<td>0.74</td>
</tr>
</tbody>
</table>

5.2.2.2 Diastolic blood pressure

No group, apart from the somatic awareness group, showed a statistically significant decrease in DBP from the pre-test to the post-test. The mean decrease in diastolic blood pressure in this group was 8.89 mmHg (p = 0.01) (Table 5.5). The eta squared statistic (0.62) indicated a large effect size, and these results suggest that somatic awareness exercise is effective in decreasing blood pressure values in stressed individuals.

Table 5.5: Mean resting diastolic blood pressure values from pre-test to post-test for the five groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Aerobic</td>
<td>84.80</td>
<td>13.04</td>
<td>82.13</td>
<td>13.76</td>
<td>0.30</td>
</tr>
<tr>
<td>Somatic</td>
<td>81.67</td>
<td>9.06</td>
<td>72.78</td>
<td>11.66</td>
<td>0.01</td>
</tr>
<tr>
<td>Combination</td>
<td>78.75</td>
<td>10.18</td>
<td>71.75</td>
<td>11.89</td>
<td>0.06</td>
</tr>
<tr>
<td>Exercise</td>
<td>75.44</td>
<td>7.37</td>
<td>74.89</td>
<td>9.35</td>
<td>0.90</td>
</tr>
<tr>
<td>Control</td>
<td>79.33</td>
<td>13.09</td>
<td>80.67</td>
<td>7.35</td>
<td>0.63</td>
</tr>
</tbody>
</table>
5.2.2.3 Resting heart rate

A statistically significant decrease of 6.78 occurred in the heart rate from pre-test to the post-test in the somatic group (p = 0.00). The eta squared statistic of 0.71 indicated a large effect size. There were no significant changes for the control, combination, exercise and aerobic groups (Table 5.6) from pre- to post-test. These results signify that somatic awareness exercise is an effective way to decrease resting heart rate in moderately to highly stressed individuals.

Table 5.6: Mean resting heart rate from pre-test to post-test for the five groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Aerobic</td>
<td>75.33</td>
<td>11.31</td>
<td>70.67</td>
</tr>
<tr>
<td>Somatic</td>
<td>76.22</td>
<td>7.65</td>
<td>69.44</td>
</tr>
<tr>
<td>Combination</td>
<td>71.50</td>
<td>6.21</td>
<td>75.50</td>
</tr>
<tr>
<td>Exercise</td>
<td>70.63</td>
<td>6.63</td>
<td>70.89</td>
</tr>
<tr>
<td>Control</td>
<td>77.60</td>
<td>16.18</td>
<td>78.80</td>
</tr>
</tbody>
</table>

5.2.3 Body sway

Body sway data was analysed and converted into coordinates of X and Y values. The coordinate values are shown in Table 5.7. X coordinates indicate movement along the X-axis (left or right direction) and Y coordinates indicate movement along the Y-axis (forward and back). The X and Y coordinates are shown in real acceleration (Realacc) values, which allow the data to be more accurate since the force of gravity has been eliminated from the values.

In Table 5.7, the “Coord” column is the coordinate values for the X and Y for each group. The right hand column “p” is the statistical significant value from the t-test. The mean, direction, standard deviation and range are shown for both the pre-test and the post-test in all the different groups. The direction column explains the total movement that the group moved in, in other words if the X coordinate’s value is positive it indicates a total movement to the right (see Table 4.4).
<table>
<thead>
<tr>
<th>Group</th>
<th>Coord</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerobic</td>
<td>X</td>
<td>—0.01</td>
<td>0.09</td>
<td>—0.02-0.19</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>—0.22</td>
<td>0.23</td>
<td>—0.72-0.00</td>
</tr>
<tr>
<td>Somatic</td>
<td>X</td>
<td>—0.01</td>
<td>0.09</td>
<td>—0.02-0.09</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>—0.22</td>
<td>0.23</td>
<td>—0.72-0.00</td>
</tr>
<tr>
<td>Combination</td>
<td>X</td>
<td>0.01</td>
<td>0.03</td>
<td>—0.02-0.05</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>—2.30</td>
<td>4.94</td>
<td>—12.36-10</td>
</tr>
<tr>
<td>Exercise</td>
<td>X</td>
<td>0.01</td>
<td>0.03</td>
<td>—0.05-0.04</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>—0.18</td>
<td>0.25</td>
<td>—0.77-0.03</td>
</tr>
<tr>
<td>Control</td>
<td>X</td>
<td>0.00</td>
<td>0.03</td>
<td>—0.06-0.03</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>—0.21</td>
<td>0.11</td>
<td>—0.38-0.07</td>
</tr>
</tbody>
</table>
It can be seen in Table 5.7 that there is a statistically significant increase in the body sway in the X coordinate from pre-test to the post-test of $p = 0.02$ in the somatic group. Further inspection of the body sway data indicates that this statistically significant result is due to an outlier. There were no significant changes in any of the other groups.

In the next section, the X and Y coordinates from Table 5.7 will be represented graphically for each group.

5.2.3.1 Graphical representation of sway data

All the body sway values were plotted onto scatter graphs, each coordinate being plotted along the X and Y axis. All the points together make up an area of movement over a period of thirty seconds, in other words it depicts the actual body sway of each subject.

In these scatter graphs, the zero on the X and Y-axis is the reference point where movement begins. Thus, one wants the body sway movement to have the smallest area possible and to be as close to zero as possible in order to show greater stability of movement (Hunter & Kearney, 1981; Ishida et al., 2010; Pellecchia, 2003). If there is an improvement from the pre-test to the post-test, then the movement depicted in the graph as coordinates may be closer to zero (centralised), less scattered and smaller in area.
5.2.3.1.1 Body sway in the Aerobic Group

Figure 5.1: Scatter graph of the whole aerobic group body sway coordinates (The pre-test X and Y coordinates are plotted in blue and the post-test X and Y coordinates are plotted in red)

The X and Y coordinates for the whole of the aerobic group are shown in Figure 5.1. The pre-test movement is predominately along the X-axis. The post-test movement is predominantly along the X-axis and in the Y-axis the area is larger than in the pre-test. The increase in area is an indication that body sway increased from the pre-test to the post-test. This can imply that aerobic exercise was not successful in decreasing body sway in moderately to highly stressed individuals.
5.2.3.1.2  Body sway in the Somatic Group

Figure 5.2: Scatter graph of the whole somatic awareness group body sway coordinates
(The pre-test X and Y coordinates are plotted in blue and the post-test X and Y coordinates are plotted in red)

The post-test movement for the somatic awareness group differs from the pre-test movement (Figure 5.2). The post-test movement appears to be from the left to the right, which is due to an outlier which can be seen in Figure 5.2. This outlier creates the illusion of a greater post-test area and may also account for the statistically significant X value (Table 5.7). This originally indicated that there was an increased body sway, but the outlier has a smaller and more centralised pattern than the pre-test sway pattern, indicating that there was an decrease in body sway in moderately to highly stressed individuals who participated in somatic awareness exercise.

The decreased perceived stress in the somatic awareness group (Table 5.3) could be indicated by the decreased body sway area (Balaban & Thayer, 2001).
5.2.3.1.3 Body sway in the Combination Group

Figure 5.3: Scatter graph of the whole combination group body sway coordinates (The pre-test X and Y coordinates are plotted in blue and the post-test X and Y coordinates are plotted in red)

In Figure 5.3, the whole combination group body sway data is shown. The pre-test coordinate at the X-value of -12.00 is an outlier. Upon further inspection it can be seen that the pre-test area is larger and less centralised than the post-test sway area. Although the results were not statistically significant (Table 5.7), there is a graphical decrease in body sway in the combination group for moderately to highly stressed individuals.
5.2.3.1.4 Body sway in the Exercise Group

The whole exercise group sway data is shown in Figure 5.4. The pre-test sway data has two outliers. When comparing the pre- and post-test representations, the post-test data is smaller in area and closer to zero in spite of the outliers. This may imply that the addition of somatic awareness exercise to aerobic exercise is effective in reducing body sway in trained moderately to highly stressed individuals.
5.2.3.1.5 Body sway in the Control group

The control group body sway area can be seen in Figure 5.5, and there was no decrease in body sway from the pre-test to the post-test. The post-test sway data is larger in area than the pre-test area, which signifies that the body sway increased.

Figure 5.5: Scatter graph of the whole control group body sway coordinates (The pre-test X and Y coordinates are plotted in blue and the post-test X and Y coordinates are plotted in red)

When examining all the scatter graphs, the body sway decreased in the somatic awareness, combination and exercise group. The aerobic group and the control group, which did not include somatic awareness exercise showed no decrease in body sway. This might propose that somatic awareness exercise decreased body sway in this study.
5.2.4 Subject Compliance

Monitoring of subject compliance is necessary because the total amount of exercise sessions may determine the efficacy of the intervention (Arrol & Beaglehole, 1992). The total number of exercise sessions of somatic awareness exercise and aerobic exercise for the five groups is shown in Table 5.8. Table 5.8 shows the “actual participation” which is the total number of sessions the participants engaged in and the “required participation” which was the required number of sessions for the eight-week period. The required amount of sessions was calculated by multiplying eight weeks and the recommended three sessions a week, and then multiplying the number of participants in each group. The percentage was calculated by dividing the actual number of sessions with the expected number of exercise sessions and multiplying by 100, the same calculations were done by Lutz et al., (2010).

<table>
<thead>
<tr>
<th>Group</th>
<th>SAS</th>
<th>RSAS</th>
<th>%</th>
<th>AES</th>
<th>RAES</th>
<th>%</th>
<th>Total</th>
<th>Required</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>312</td>
<td>192</td>
<td>162.50</td>
<td>312</td>
<td>192</td>
<td>162.50</td>
</tr>
<tr>
<td>Somatic</td>
<td>138</td>
<td>216</td>
<td>63.89</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>138</td>
<td>216</td>
<td>63.89</td>
</tr>
<tr>
<td>COM</td>
<td>99</td>
<td>192</td>
<td>51.56</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>209</td>
<td>384</td>
<td>54.43</td>
</tr>
<tr>
<td>Exercise</td>
<td>143</td>
<td>192</td>
<td>74.48</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>253</td>
<td>384</td>
<td>65.89</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
</tbody>
</table>

COM = combination; SAS = Somatic awareness sessions; RSAS = Required somatic awareness sessions; AES = Aerobic exercise sessions; RAES = Required aerobic exercise sessions

From the values in Table 5.8, it can be deduced that the aerobic group had the largest number of aerobic exercise sessions with a percentage of 162.50%. The percentage greater than 100% indicates that the aerobic group participated in more than the required three sessions per week. The combination and the exercise group participated in the same amount of aerobic exercise sessions. Although the aerobic group had the greatest compliance it did not impact positively on objective stress measures nor did less participation in aerobic exercise negatively impact on the objective stress measures. Thus, one may assume that compliance in aerobic exercise group did not affect the present study.
The exercise group participated in the most somatic awareness sessions with a percentage of 74.78%, the somatic awareness group had less participation (63.89%) and the combination group participated in the smallest number of somatic awareness exercise sessions (51.56%). Accordingly, compliance did not positively or negatively affect indicators of subjective stress.

These results may indicate that regardless of compliance, the mere participation in aerobic or somatic awareness exercise produced a decrease in subjective stress perception, and that stress perception may be altered through the use of physical exercise regardless of type.

### 5.3 Summary of results

The summary of the results is shown in Table 5.9. The main findings of the present study were that:

- The majority of the sample constituted of Caucasian, overweight and non-smoking females,
- All modalities were successful in decreasing subjective stress indicators and
- Only somatic awareness was effective in decreasing all objective stress indicators (chronic physical manifestations).

#### Table 5.9: A summary of the statistically significant results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress score</td>
<td>Exercise</td>
<td>0.00</td>
</tr>
<tr>
<td>Stress score</td>
<td>Aerobic</td>
<td>0.02</td>
</tr>
<tr>
<td>Stress score</td>
<td>Somatic</td>
<td>0.00</td>
</tr>
<tr>
<td>Stress score</td>
<td>Combination</td>
<td>0.00</td>
</tr>
<tr>
<td>Body Mass</td>
<td>Exercise</td>
<td>0.04</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>Somatic</td>
<td>0.00</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>Somatic</td>
<td>0.01</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>Somatic</td>
<td>0.002</td>
</tr>
<tr>
<td>Body Sway X Coordinate</td>
<td>Somatic</td>
<td>0.018</td>
</tr>
</tbody>
</table>

Of all the interventions tested, somatic awareness exercise per se proved to be the only intervention able to show an improvement in most of the subjective and objective stress indicators, and thus the chronic physical manifestations of the stress response.
CHAPTER 6

DISCUSSION

6.1 Introduction

In this chapter, the findings of the present study will be interpreted and discussed. The research question in determining what kind of exercises would be the most effective in reducing subjective stress levels and its chronic physical ramifications, will be mentioned throughout the chapter by placing emphasis on the modality, which was successful in decreasing subjective and objective stress measures.

6.2 Perceived stress

6.2.1 Introduction

The results of the present study indicate that aerobic and somatic awareness exercise, whether alone or in combination with other exercise, in trained and untrained individuals, will decrease psychological stress in moderately to highly stressed individuals (Table 5.3). This is an interesting finding since in the present study, all the groups except the control group, had significant reductions in perceived stress.

These results indicate that irrespective of exercise modality and the combinations of exercise, one can bring about stress reduction by means of physical activity as long as one perceives the activity to be enjoyable. This was also found by Asztalos, Wijndaele, de Bourdeaudhuij, Philippaerts, Matton, Duvigneaud, Thomis, Lefevre and Cardon (2012) and Bond et al., (2002). It is possible to decrease one’s stress, irrespective of the type of physical activity modality, because physical activity is a controllable stressor, and it decreases the distress an individual experiences, aids in releasing physical energy and according to some studies, produces resistance against other stressors (Maier & Seligman, 1976; Salmon, 2001; Willner, 1985). In other words, exercise not only reduces the stress response of past stressors, but also reduces the effects of other possible stressors and thus there is a reduction in perceived stress in all the intervention groups. The findings of each intervention group will be discussed individually in the following sections.
6.2.2 Perceived stress and aerobic exercise protocol

The aerobic exercise protocol in this study was only moderately effective in decreasing perceived stress as there was an effect size of 0.33, an effect size which is medium (Cohen, 1988). This is probably due to the fact initial exposure to aerobic exercise in volunteers may increase perceived stress (Lutz, Lochbaum, Lanning, Stinson & Brewer, 2007; Ng & Jeffery, 2003). Nonetheless, the modest decrease in perceived stress brought about by participation in aerobic exercise was statistically significant (Table 5.3). These results concur with those of other researchers supporting the use of physical exercise in decreasing perceived stress and improving psychological well-being (Bond et al., 2002; Buckworth & Dishman, 2002; Cox, 2002; Jackson & Dishman, 2006; King, Taylor, Haskell & DeBusk, 1989; Lutz et al., 2007; Milani & Lavie, 2009; Ng & Jeffery, 2003; Norris, Carroll & Cochrane, 1990; Steptoe et al., 1998; Weinberg & Gould, 2007).

Aerobic exercise is effective in decreasing perceived stress because it is known to induce PNS activation after the activity has ceased (Billman, 2002; Hautala, Kiviniemi & Tulppo, 2009) as well as decreasing stress sensitivity (King et al., 1989; Lutz et al., 2007; Milani & Lavie, 2009; Ng & Jeffery, 2003; Norris et al., 1990; Steptoe et al., 1998). Aerobic exercise is also effective in decreasing perceived stress because it provides a cross-stressor effect, according to the cross-stressor adaptation hypothesis proposed by Salmon (2001) (Section 2.3.6.4.2). The stretching included in the aerobic exercise protocol in this study, may also be effective in decreasing stress and inducing PNS states (Carlson, Collins Jr., Nitz, Sturgis & Rogers, 1990; Carlson & Curran, 1994; Carlson, Ventrella & Sturgis, 1987; Engel & Andersen, 2000; Kay & Carlson, 1992). Thus, aerobic exercise was only moderately effective in decreasing perceived stress due to PNS activation.

6.2.3 Perceived stress and somatic awareness

Somatic awareness was effective in decreasing subjective stress, to such an extent that it had a large effect size (effect size 0.76) (Section 5.2.1.2). From the large effect size, it can be assumed that somatic awareness training was a more effective modality in decreasing perceived stress, since it promotes and develops skills that aerobic exercise does not, such as improved kinaesthetic awareness (Alexander, 1987) (Section 3.4), and also somatic awareness based
activities are found by females to be more relaxing and stress reducing than aerobic and team
based sports (Asztalos et al., 2012).

Besides the sample demographic, there are several reasons as to why somatic awareness was
effective in decreasing perceived stress in this study:

- Firstly, the present study made use of rhythmical, predictable, non-competitive
  movements and abdominal breathing, which was found by Berger and Owen (1988) to be
  the most stress reducing and brings about PNS activation.
- Secondly, somatic awareness exercise may alter stress perception and emotional
  regulation, ultimately decreasing perceived stress (Chambers, Gullone & Allen, 2009;
  Dobkin, 2008; Holzel et al., 2011; Miller et al., 1995). This may, amongst other things,
  be due to factors such as PNS activation (Bloom, 2006; Brooks, 1974; Frieder, 2007;
  Homann, 2010; Miller et al., 1995; Rothschild, 2000; Schore, 2003).
- Thirdly, somatic awareness techniques have been found to improve sensory processing
  (Kilpatrick, Suyenobu, Smith, Bueller, Goodman, Creswell, Tillisch, Mayer & Naliboff,
  2011), internal feedback and internal attention (Connors, Galea, Said & Remedios, 2010;
  Kerr et al., 2002; Kolt & McConville, 2000). As has been pointed out before (Section
  3.1), an increased ability to pay attention to one’s internal feedback and process sensory
  information allow better stressor perception, which in turn will allow the individual to
  respond in a manner which is less stressful. One responds in a manner which is less
  stressful because ingrained habitual stress patterns are reversed (Alexander, 1985), there
  is improved feedback and one expresses the stress response with increased efficiency
  (Bloom, 2005; Hanna, 1993; Reich, 2002). Ultimately, there is a reduction in SMA
  (Hanna, 1993) and the improved motor patterns allow one to adapt to stressors (Lewis &
  Todd, 2007).

The combination of modalities in untrained and previously trained individuals will be discussed
in the next section.
6.2.4 Perceived stress and the combination of aerobic exercise and somatic awareness training

The combination of somatic awareness and aerobic exercise successfully decreased perceived stress in both untrained and previously trained individuals (Table 5.3). This may be due to the combination of two modalities inducing PNS activation (Section 6.2.2 & Section 6.2.3), as the combination of more than one modality has been shown to be more effective than one modality alone (Consolo et al., 2008; Cox, 2002; Feldman et al., 2010; Hinton et al., 2006; Irving, Dobkin & Park, 2009; Kabat-Zinn, 2005; Khan et al., 2008; Quick et al., 1997).

If one compares the effectiveness of the exercise modality by examining the effect size of the mean perceived stress, the combination group had the same effect size as the somatic awareness group (0.76) and the exercise group also had a large effect size (0.75) (Section 5.2.1). It is possible that the addition of the somatic awareness exercise was accountable for the large effect size in the combination (0.76) and exercise group (0.75), because the somatic awareness protocol had a larger effect size (0.76) than the aerobic group (0.33) in this case.

An interesting point to note here is the statistically significant decrease in perceived stress due to the addition of somatic awareness in the exercise group. Since the exercise group were individuals who previously trained in aerobic exercise, they were supposed to already have a physical coping mechanism. Yet, the exercise group was experiencing the same moderate to high levels of stress that the other non-exercising groups did, indicating that the aerobic exercise, in the long run, is not a successful coping mechanism against perceived stress. It was thus the sole addition of the somatic awareness that caused the large effect size (0.75) and the statistically significant stress score decrease in the exercise group, indicating how successful somatic awareness training is in decreasing perceived stress.

Not only did somatic awareness exercise produce the largest effect size and mean score difference in comparison to the other groups, it also successfully decreased perceived stress in trained individuals. Thus, the results of this study suggest that somatic awareness training may be used alone or coupled to aerobic exercise to induce large decrements in perceived stress.
6.3 Objective measurements

In this section the various objective measures such as cardiovascular values (blood pressure & heart rate) and body sway will be discussed and the results examined.

6.3.1 Cardiovascular responses

6.3.1.1 Somatic awareness and cardiovascular responses

Although there are studies where somatic awareness protocols did not yield positive results in decreasing blood pressure and heart rate (Song, Lee, Lam & Bae, 2003; Thomas, Hong, Tomlinson, Lau, Lam, Sanderson & Woo, 2005), it was not the case in the present study. Somatic awareness was the only modality in this study to significantly decrease and produce large effect sizes for blood pressure and heart rate (Tables 5.4, 5.5 and 5.6). So much so, that the mean systolic (8.33 mmHg) blood pressure differences were greater than other aerobic research differences of 2 mmHg found by Kelly (1999) and the 4.7 mmHg by Halbert, Silagy, Finucane, Withers, Hamdorf and Andrews (1997); and the 2.8 mmHg in passive life skills training (Gregoski, Barnes, Tingen, Harshfield & Treiber, 2011).

The decrease of the mean diastolic blood pressure of 8.89 mmHg found in the present study is greater than that found by Gregoski et al. (2011), who studied passive life skills training (mean difference: 2.95 mmHg) and aerobic exercise, where differences were found to be 3.1 mmHg (Halbert et al., 1997) and 1mmHg (Kelly, 1999).

The decrease in the mean resting heart rate by 6.78 bpm in the present study was larger than the those for Yoga and passive life skills training, where mean differences were found to be 4 bpm (Carlson et al., 2007) and 3.2 bpm respectively (Gregoski et al., 2011).

The results of the present study coincide with the abundance of somatic awareness/mindfulness research that supports the use of somatic awareness techniques such as mediation, Tai Chi, Qi Jong and Yoga to decrease blood pressure and heart rate (Alexander, Langer, Newman, Chandler & Davies, 1989; Carlson et al., 2007; Channer, Barrow, Barrow, Osborne & Ive, 1996; Courtney, 2009; Frishman, Grattan & Mantani, 2005; Gilmartin, 2009; Lee, Lim & Lee, 2004; Mills & Allen, 2000; Monson, 2010; Raju, Prasad, Venkata, Murthy & Reddy, 1997; Salmon, Lush, Jablonski & Sephton, 2009; Singh, Malhotra, Singh, Madhu & Tandon, 2004; Sudsuang,

The PNS activation occurs because peripheral relaxation (brought about, for example, by somatic awareness) causes a neural shift toward trophotropic activation and decreased “ergotropic tone of the hypothalamus, a diminution of hypothalamic-cortical discharges, and consequently, to a dominance of the trophotropic system through reciprocal innervation” (Gellhorn & Kiely, 1972: 404). Thus, according to Conrad and Roth (2007: 248), “muscle relaxation in the periphery results in a centrally mediated shift of the bodily system towards a trophotropic response.” This in turn induces vasodilation, reduces overall bodily and muscle tension, and alters stress perception which then decreases blood pressure and heart rate (Conrad & Roth, 2007; Schneider, Alexander, Staggers, Rainforth, Salerno, Hartz, Arndt, Barnes & Nidich, 2005; Schneider, Staggers, Alexander, Sheppard, Rainforth, Kondwani, Smith & King, 1995).

Altered stress perception decreases blood pressure and heart rate because the two share a directly proportional relationship (Allen, Matthews & Sherman, 1997; Balanosa, Phillips, Frenneaux, McIntyre, Lykidisa, Griffina & Carroll, 2010; Black, 2003; Cacioppo, 1994; Vrijkotte, van Doornen & de Geus, 2000): if stress increases, there will be an increase in blood pressure and

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3 Trophotropic activation: parasympathetic activation of the nervous system that promotes relaxation, repair and rest, resulting in decreased heart rate and blood pressure (Conrad & Roth, 2007; Benson, Benson, 1975).

4 Ergotropic: the sympathetic activation of the “fight or flight” mechanisms in preparation for the physiological stress response (Conrad & Roth, 2007).

The reverse is also true, since a reduction in stress perception will reduce blood pressure and heart rate (Bartholomew, 2000; Blumenthal, Sherwood, Gullette, Georgiades & Tweedy, 2002; Carels, Blumenthal & Sherwood, 2000; Carroll, Harris & Cross, 1991; Sherwood, Allen, Obrist & Langer, 1986; Stewart & France, 2001). Hence, an improved emotional state (decreased perceived stress) in the somatic awareness group (Section 6.2.3), may also bring about an improved bodily state due to muscle relaxation (Jacobson, 1903a, 1903b), and the combination of factors then reduces blood pressure and heart rate (Buttagat, Eungpinichpong, Chatchawan & Kharmwan, 2011; Conrad & Roth, 2007; Feldenkrais, 2002; Hanna, 1993; Lehrer et al., 2009; Pagani et al., 1988; Potts et al., 1993; Potts et al., 1998; Shoemaker & Tasto, 1975; van Roon et al., 2004).

Thus, somatic awareness was highly successful in decreasing blood pressure and heart rate in this study, because it increases emotional well-being and the combination of breathing, mindfulness and muscle relaxation induces a PNS response.

6.3.1.2 Cardiovascular responses and aerobic exercise training

The prescribed aerobic exercise training programme in the present study proved not to be effective in significantly decreasing blood pressure and heart rate (Tables 5.4, 5.5 & 5.6). This is surprising as aerobic exercise training has been shown to decrease blood pressure and heart rate in the long term due to PNS activation (vagal stimulation) and SNS deactivation (Billman, 2002; Casonatto & Doederlein, 2009; Cottin, Medigue & Papelier, 2008; Crowley, McKinley, Burg, Schwartz, Ryff, Weinstein, Seeman & Sloan, 2011; Hambrecht, Walther, Mobius-Winkler, Gielen, Linke, Conradi, Erbs, Kluge, Kendziorra, Sabri, Sic & Schuler, 2004; Kiyonaga, Arakawa, Tanaka & Shindo, 1985; Levy, Cerqueira, Harp, Johannessen, Abrass, Schwartz & Stratton, 1998; Sandercock, Bromley & Brodie, 2005). Although the aerobic exercise did not improve static cardiovascular responses in this study, it could decrease the acute physical responses to stress, so that blood pressure and heart rate do not rise as much or as rapidly.
(Anshel, 1996). This may offer an explanation to the reduced stress perception, but not to changes in cardiovascular parameters in the aerobic group (Section 6.2.2).

Several factors may have hindered the improvement in blood pressure and heart rate in the aerobic group. The eight-week study duration was chosen because it is a sufficient amount of time to allow for physiological adaptations to exercise to occur (Halbert et al., 1997; Hamer et al., 2006; Holmes & McGilley, 1987; Whelton, Chin, Xin & He, 2002), however eight-weeks may not have been an adequate time frame to bring about cardiovascular adaptations such as decreased blood pressure and heart rate (Brook & Long, 1987; Gillett, Caserta, White & Martinson, 1995; Gillett, White & Caserta, 1996; Hamdorf, Withers, Penhall & Haslam, 1992; Kelly, 1999; Messerli, Williams & Ritz, 2007; Murphy & Hardman, 1998).

The increased compliance in the aerobic group (162.50%) (Section 5.2.4) may have acted as a stressor and affected coping through increased overload (Seery, 2011), even though the moderate intensity used in this study has previously been used to improve stress (Cox, 2002). However, it is more likely that the moderate exercise intensity prescribed to subjects in the present study was not sufficient to induce changes in resting blood pressure and heart rate (Seery, 2011), and a higher intensity may have been more beneficial (Reed & Buch, 2009).

The duration of the exercise sessions (20-30 minutes) may have limited cardiovascular improvements as researchers found shorter exercise sessions to be more successful in decreasing blood pressure and heart rate than longer bouts (Hansen et al., 2001; Pate, Pratt, Blair, Haskell, Macera, Bouchard, Buchner, Ettinger, Heath, King, Kriska, Leon, Marcus, Morris, Paffenbargar, Patrick, Pollock, Rippe, Sallis & Wilmore, 1995).

6.3.1.3 Cardiovascular responses and combined modalities of exercise

The combined exercise (aerobic and somatic awareness) in the untrained (combination group) and the previously aerobic trained individuals (exercise group) was also not successful in decreasing blood pressure and heart rate (Tables 5.4, 5.5 & 5.6). This again was unexpected because the combination of physical modalities has been recognised to reduce blood pressure and heart rate values (Carter, Banister & Blaber, 2003; Feldman et al., 2010; Quick et al., 1997; Radak, Chung, Koltaï, Taylor & Goto, 2008; Zhang & Zhang, 2009).
Arrol and Beaglehole (1992) found that reduced compliance hinders the adaptations that occur with aerobic exercise, such as reduced blood pressure and heart rate. The exercise and combination group may not have had reductions in blood pressure and heart rate because both groups had low levels of aerobic exercise participation with only 57.29% compliance (Table 5.8). As the aerobic protocol used in the combination group was the same as the aerobic group, the study duration, intensity and session length may have also limited decreases in blood pressure and heart rate (Section 6.3.1.2).

Even though the exercise group had the highest level of somatic awareness exercise participation (74.78%) (Table 5.8), it appears that here the somatic awareness exercise was not effective in decreasing blood pressure and heart rate, reasons for this remain unclear. Decrements in blood pressure and heart rate were not expected from the aerobic exercise in this group, as these individuals were accustomed to exercise and there was no training load included in their protocol.

Thus, the combination of somatic awareness exercise and aerobic exercise was not successful in decreasing blood pressure and heart rate in this study in trained and untrained individuals.

### 6.3.2 Body sway

In this section, the role of different exercise modalities on body sway will be discussed. A discussion on whether or not the entire study’s pre-test body sway data was below or above standard norms cannot be determined yet, as no norms exist. Nevertheless, there are several factors within the research that may contribute to an increased body sway such as the female gender (Bryant, Trew, Bruce, Kuisma & Smith, 2005), increased weight (Hue, Simoneau, Marcotte, Berrigan, Dore´, Marceau, Marceau, Tremblay & Teasdale, 2007) and increased stress levels (Alpers & Adolph, 2008; Balaban & Porter, 1998; Gotoa et al., 2011; Ishida et al., 2010; Nagaratnam et al., 2005; Ohno et al., 2004; Redfern et al., 2007; Wada et al., 2001; Yardley et al., 1995).

#### 6.3.2.1 Somatic awareness and body sway

The somatic awareness exercise was the only modality in this study that managed to decrease body sway significantly (Table 5.7). Increased stress increases cognitive demand. Cognitive demand is linked to motor performance. Therefore, an increase in stress will decrease fine motor
control, balance and increase body sway because of limited capacity of attention (Pellecchia, 2003) and the adaptive posture response in response to stress (Andersson, Hagman, Talianzadeh, Svedberg & Larsen, 2002). Thus, if there was an improvement in stress levels as shown in the present study (Section 6.2.3), then there would be a decrease in body sway (Balaban & Thayer, 2001). However, greater decreases with the body sway may have been noted if there was balance specific training (Caldwell, Harrison, Adams & Triplett, 2009).

Thus, somatic awareness exercise was successful in decreasing body sway because of the decreased subjective and objective stress measures. It may also be the addition of the somatic awareness exercise (not the aerobic exercise) in the trained (exercise group) and untrained individuals (combination group), that managed to decrease body sway graphically (Figure 5.3 and 5.4).

Thus, the main hypothesis is disproven in this case, since the combination group was not the most successful modality in decreasing perceived and the chronic physical manifestations, but rather the somatic awareness training.

6.3.2.2 Aerobic exercise and body sway

In the present study, aerobic exercise did not lead to statistically significant decreases in body sway (Figure 5.1). Aerobic exercise did not aim to improve sensory systems and sensory awareness as the somatic awareness exercises did. Body sway is dependent on sensory systems and sensory awareness. When there is dysfunction of a vestibular or proprioceptive system (sensory system), as when one is stressed and there are no improvements in physical stress, then there is poor or increased body sway (Demura & Uchiyam, 2009).

Studies using aerobic exercise found that aerobic exercise training did have small influences on body sway directly after exercise (Demura & Uchiyam, 2009) and in some studies there was an increase in body sway (Fox, Mihalik, Blackburn, Battaglini, & Guskiewicz, 2008; Yaggie & Armstrong, 2004). However, there was no research found which solely supports the use of aerobic exercise to decrease body sway.
CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Based upon the results of the present study, it may be concluded that various physical modalities such as aerobic exercise, somatic awareness training and the combination of the two may be used to decrease one’s perceived stress levels in moderately to highly stressed individuals. Out of all the modalities, the somatic awareness training proved to be the most successful in lessening perceived stress through subjective methods, as well as the only modality to reduce physiological stress through objective stress measurements (blood pressure, heart rate and body sway).

Somatic awareness has value in decreasing stress when used solely or in combination with other modalities of physical activity. As a result of this, somatic awareness will provide stress reducing benefits to trained individuals who are already partaking in physical exercise, by not only decreasing perceived stress but also by improving muscle tension, balance, cardiovascular parameters, overall health and by decreasing body sway. Reasons for the addition of somatic awareness training include the benefits of PNS activation, perception of the relaxation response and changes in stress sensitivity, without the use of pharmacological drugs with harmful side effects.

7.2 Application for the current research

The findings of this study revealed important implications for Biokineticists who are aiming to decrease stress levels in their patients. As stressor perception will ultimately determine activation of the stress response, one can cater for a wide variety of trained and untrained patients depending on what they deem physically enjoyable. This allows the Biokineticist to bring about a reduction in stress levels with a variety of enjoyable physical activities that are specific to each patient. These vary from aerobic activities to mindful techniques.

Implementation of somatic awareness training (which includes combinations of breathing, mindfulness, movement and inner sensing) is recommended for applying in private practice and
in the corporate setting to reduce the chronic physical manifestations of the stress response and teach improved stress-response patterns to individuals who are experiencing moderate to high stress levels.

7.3 Recommendations

There are several suggestions for future research based on the present study’s limitations as well as the lack of available research on the protocol utilised.

- The sample consisted mainly of white, overweight, non-smoking females. Further research should be conducted with different gender and ethnical groups.
- The present study had a small sample size in some of the groups (n = 9) and a larger sample size would be appropriate for future studies in order to improve validity.
- A longitudinal study (> 8 weeks) using various aerobic sessions and intensities should be compared with somatic awareness activities, as the success of an eight-week study was inconclusive.
- Future studies should include additional markers for stress in order to determine the effectiveness of somatic awareness training and aerobic exercise on objective physiological improvements. These improvements include the hormonal (cortisol), neurological (adrenaline), cerebral (EEG), biological (immune markers, free radicals) and movement systems (functional connectivity MRI).
- Inclusion of the role of improvements in other life style factors such as nutritional habits, smoking and alcohol intake as a tool for the long term management of chronic stress.
- Various somatic awareness techniques such as the protocol used in this study, Yoga, Tai Chi and Qi Jong should be compared to determine which technique would be more effective.
- Posture analysis would be a useful tool to determine if stressed populations exhibit certain “stressed postures” and if an improvement in stress would improve one’s posture.
REFERENCES


van Niekerk, L. (2010). *Stress*. Personal communication, July 2011, Johannesburg. (Senior Lecturer: Psychology and Sport Psychology, Department of Psychology)


APPENDIX A

INFORMED CONSENT FOR BIOMECHANICAL AND NON-INVASIVE PHYSIOLOGICAL RESEARCH

UNIVERSITY OF JOHANNESBURG
OFFICE OF RESEARCH ETHICS

Date: October 2012

Title of Project: Chronic Physical Manifestations of Stress

Researcher: Michelle Das Neves (0823965895)

Institution: University of Johannesburg

Department of: Sport and Movement Studies (011 559-3005)

Supervisor: Professor J.M. Loots (DSc, DTech) (012 808 1243)

Institution: University of Johannesburg

Department of: Sport and Movement Studies (011 559 3005)

Co-Supervisor: Dr L. van Niekerk (DPhil)

Institution: University of Johannesburg

Department of: Psychology (011 559 2082)
INVITATION TO PARTICIPATE

You are invited to participate in the “The effect of somatic awareness exercise on the chronic physical manifestations of stress” research programme. It is conducted on an entirely voluntary basis and you will not be compelled to participate or continue with the study while it is still in process if you do not feel comfortable doing so.

PURPOSE OF THIS STUDY

This research study is designed to evaluate exercise and its effect on the chronic physical manifestations of stress. The study involves various exercise techniques to determine the effect each has on the chronic manifestations of stress.

PROCEDURES INVOLVED IN THIS STUDY

TIME COMMITMENT

Participation in this study will require approximately 2½ hours of your time for pre-testing which will comprise of a 30-minute orientation session and a two-hour testing session. Following an eight week period of intervention a further two hours will be needed for post-testing. Some time (one hour per day, 3 times a week) will also have to be devoted to the maintenance of your programme during the period of intervention.

SELECTION BASIS

All participants who indicate that they are prepared to enter the study will undergo a screening process based on certain exclusion and inclusion criteria. This requires the completion of a questionnaire (Appendix B) and a medical screening form (Appendix C) to determine whether you meet the criteria for participation in the study. If you meet these criteria, you will be contacted to participate in the pre-testing.
PRE-TESTING:

The pre-testing will take place at the University of Johannesburg Gym at the Kingsway Campus. The main researcher will be present with the supervisor. A full session of this testing will last approximately two-and-a-half hours. Included in a two-hour biomechanical and physiological assessment will be:

1. **Vitals:** Resting Heart Rate and Blood pressure.
2. **Anthropometry:** The first set of tests will include height and weight measurements. These materials will be stored in a locked office. Names of participants will be removed and a number will be assigned.
3. **Body sway assessment:** visual methods will be used to measure body sway.

The orientation session will follow the completion of the assessment. It consists of the intervention that needs to be completed along with a demonstration of the various exercises. You will be given a CD with the exercises and an exercise diary.

INTERVENTION:

An eight-week period of intervention is required with each participant. You will be required to do the exercises demonstrated on the CD handed to you at least three times a week. The duration of each exercise session will be about 45-60 minutes.

Once you have completed the exercises for the session, please record your session in the exercise diary (Appendix D). The various procedures and completion of the diary will be explained in more detail in the orientation session.

POST-TESTING:

After the eight-week intervention, participants will be asked to return for post-testing. The same assessment as done in the pre-testing will then be repeated.
THE RIGHT TO PRIVACY, CONFIDENTIALITY AND ANONYMITY

All participants are assured of anonymity and confidentiality. All documents and results will remain anonymous so that it is not possible to identify the participants. Appropriate methods are devised to ensure privacy at the time of data collection. To ensure the confidentiality of individuals’ data, each participant will be identified by a participant identification code known only to the principal researcher and her research supervisors.

The obligation to maintain privacy, anonymity and confidentiality extends to the entire research team, other researchers in the institution, the administrative staff, and all those (from or outside the institution) not directly associated with the research who may possibly have access to the information. Researchers maintain appropriate anonymity and confidentiality of information in creating, storing, accessing, transferring and disposing of records under their control, whether these are written, automated or in any other medium.

Sometimes a certain photograph and/or part of a videotape clearly may show a particular feature or detail that would be helpful in teaching or when presenting the study results in a scientific presentation or publication, this will only be used for scientific research and will only be seen by the main researcher and her supervisor. Videotapes and/or photographs will be stored in a secure area, after three years the material will be destroyed.

RIGHT TO EQUALITY, JUSTICE, HUMAN DIGNITY
AND PROTECTION AGAINST HARM

RISKS TO PARTICIPATION AND ASSOCIATED SAFEGUARDS

- There is always a risk of muscle, joint or other injury in any physical activity. However, the risks in this study are not anticipated to be greater than those required to move your own limbs and/or encountered in an exercise programme or recreational activity that requires brief maximum muscular efforts.
- During the intervention, you may experience muscular fatigue, and/or soreness. The stiffness and/or soreness may develop or persist for two or three days following the study if you are unaccustomed to this type of exercise. This soreness/stiffness is normal and
usually disappears in a few days. If it does not go away within a few days, you should contact the researcher.

- Some individuals may experience mild skin irritation from the tape used to attach the electrodes to the skin or the gel used to moisten the electrode. This is similar to the irritation that may be caused by a bandage and typically fades within two to three days.
- You will be instructed to monitor your level of discomfort and to record this at the start, mid-point, and end of the study. In addition, you will be advised to terminate the testing session if you experience severe discomfort or at any time you feel that you can no longer continue.

THE RIGHT OF FREEDOM OF CHOICE, EXPRESSION AND ACCESS TO INFORMATION

CHANGING YOUR MIND ABOUT PARTICIPATION

You may withdraw from this study at any time without penalty. To do so, indicate this to the principal researcher or one of the research assistants.

PERSONAL BENEFITS OF PARTICIPATION

By participating in this study, you will benefit by gaining knowledge of the stress response and the different ways in which to cope. You also will further your knowledge and understanding of experimental procedures commonly used in biomechanics/ergonomics research.

FEEDBACK AND RESULTS

The results obtained and the feedback given to you will depend on whether you wish to receive the information. Should you wish to receive the information, you will be contacted after the completion of the study.

Would you like to receive feedback regarding your results in the study?

YES ☐  NO ☐
THE RIGHT OF THE COMMUNITY AND SCIENTIFIC COMMUNITY

The results obtained during the study will be used for the scientific community and for the positive influence in practice in the community.

The video and/or photographs can/may be used in teaching or scientific presentations, or published in scientific journals or professional publications of this work.

CONCERNS ABOUT YOUR PARTICIPATION

This study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Johannesburg. However, the final decision about participation is yours. If you have any comments, concerns or questions about your participation in this study, you may contact Michelle at 082 396 5895 or Professor Loots at 012 808 1243.

INFORMED RISK:

I understand that participating in the study does have risks and that I am responsible for my own well-being.

I understand that receiving medical clearance does not reduce the risk of injury(ies) that may occur while participating in the present study, including recurrence of an injury or aggravation of a pre-existing injury, illness, or condition.

In order to minimise the risk of injury/illness, I shall be aware of and abide by applicable policies, procedures, techniques, safety rules, and guidelines. I shall follow the advice of the UJ Research Team concerning the execution of the exercises that follow and understand that I am to do them at my own discretion. Furthermore, I understand that the possibility of injury/illness, including catastrophic injury/illness, does exist even though proper rules and techniques are followed to the fullest.

I understand that proper use of equipment helps only to minimise the risk of injury and no equipment can prevent all injuries which I might receive while participating in the study.
I do hereby hold harmless, indemnify and release and discharge UJ Research Team, its officers, directors, shareholders, employees, instructors, landlord and facility from all liabilities, claims, demands, injuries, damages, actions or cause of actions. This release shall unequivocally release the UJ Research Team, its affiliates, officers, shareholders, directors, employees and instructors from all claims, injuries and damages, present or future, anticipated or unanticipated, resulting from or arising out of my use or intended use of the facilities or equipment.

I, ______________________________ agree to take part in a research study being conducted by Michelle Das Neves of the Department of Human Movement Sciences at the University of Johannesburg. I have made this decision based on the information I have read in the information letter. All the procedures, any risks and benefits have been explained to me. I have had the opportunity to ask any questions and to receive any additional details I want about the study. If I have questions later about the study, I can ask one of the researchers, Michelle Das Neves (082 396 5895) and/or Professor Loots (012 808 1243).

_____________________________                      __________________________
Printed Name of Participant                                   Signature of Participant

_____________________________                      __________________________
Dated at University of Johannesburg                          Witnessed
APPENDIX B

STRESS QUESTIONNAIRE

Instructions: The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last month, how often have you been upset because of something that happened unexpectedly?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

2. In the last month, how often have you felt that you were unable to control the important things in your life?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

3. In the last month, how often have you felt nervous and "stressed"?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

4. In the last month, how often have you felt confident about your ability to handle your personal problems?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

5. In the last month, how often have you felt that things were going your way?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

6. In the last month, how often have you found that you could not cope with all the things that you had to do?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

7. In the last month, how often have you been able to control irritations in your life?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

8. In the last month, how often have you felt that you were on top of things?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

9. In the last month, how often have you been angered because of things that were outside of your control?
   ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
    ___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

APPENDIX C

PRE-PARTICIPATION MEDICAL SCREENING

Name: ____________________________ Surname: _________________________
DOB: _____________________________
Contact number: ____________________
Doctor’s Name______________________ Doctor’s Contact #: ________________
Emergency Contact__________________ Emergency Contact #: ______________

Instructions for completion:

- Participants who fail to complete the Pre-Participation Medical Screening Form completely or accurately will be excluded from the study automatically.

- Mark "yes" or “no” next to each item that corresponds to a medical or health issue on the following pages. After marking "yes", if it is required, please give more details in the space provided.

- Include any ongoing medical care that you are receiving and if you currently have any restrictions or limitations due to the particular condition.

- Please answer all the items.

- In the Acknowledgement and Authorisation section, you are required to check “YES” and initial each item to acknowledge that you have read and understand each statement. If you find that you cannot agree to each item, you will not be allowed to participate in the study.

- If you marked "yes" for any condition, describe the condition or concern in the space provided.
**Cardiovascular:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>Explanation/ When event occurred or was diagnosed</th>
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</thead>
<tbody>
<tr>
<td>1 Change in resting ECG suggesting ischemia, myocardial infarction or other acute cardiac event. If yes, please state.</td>
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<td>2 Unstable angina</td>
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<td>3 Uncontrolled cardiac dysrhythmia causing symptoms or haemodynamic compromise</td>
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<td>4 Aortic stenosis</td>
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<td>5 Symptomatic heart failure</td>
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<td>6 Pulmonary embolus or infarction</td>
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<td>7 Acute myocarditis or pericarditis</td>
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<td>8 Dissecting aneurysm</td>
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<td>9 Left artery stenosis</td>
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<td>10 Stenotic valvular heart disease</td>
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<td>11 Tachydysrhythmia or bradydysrhythmia</td>
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<td>12 Hypertonic cardiomyopathy</td>
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<td>13 Atrioventricular block</td>
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<td>14 Ventricular aneurysm</td>
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<td>15 High blood pressure, If yes, please state the known value.</td>
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<td>16 Heart attack</td>
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<td>17 Heart failure</td>
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<td>18 Stroke</td>
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<td>19 Pacemaker</td>
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<td>20 Bypass</td>
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<td>21 Heart murmur</td>
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<tr>
<td>22 Bleeding disorders</td>
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<td>23 Irregular or extra heart beats</td>
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<td>24 ECGs in the past/history of abnormal ECGs, If Yes, please state when.</td>
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## Orthopaedic:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>1 Joint replacements. If yes, please state which joint.</td>
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<td>2 Muscle strains. If yes, please state where.</td>
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<td>3 Ligament/tendon sprains. If yes, please state where</td>
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<td>4 Muscle tears. If yes, please state where.</td>
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<td>5 Arthritis. If yes, please state which joint.</td>
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<td>6 Broken bones. If yes, please state which bone.</td>
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<td>7 Joint injury. If yes, please state which joint and what kind of injury.</td>
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<td>8 Head injury/concussion? If yes, please State</td>
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<td>9 Pinched Nerve. If yes, Please state where and which nerve.</td>
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<tr>
<td>10 Acute injury (not mentioned), If yes, please state.</td>
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<td>11 Chronic injury (not mentioned), if yes, please state.</td>
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## Chronic:

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<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>1 Electrolyte abnormalities e.g. Hypokalemia. If yes, please state.</td>
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<td>2 Uncontrolled metabolic disease. If yes, please state.</td>
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<td>3 Chronic infectious disease. E.g. Hepatitis. If yes, please state.</td>
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<td>4 Osteoporosis</td>
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<td>5 Diabetes</td>
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<td>6 Seizures</td>
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<td>7 Asthma/exercise-induced asthma</td>
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<td>8 Loss or problem with any paired organs (e.g. eyes, testicles, ovaries, kidneys, breasts)</td>
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<td>9 Do you have allergies?</td>
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<td>10 Have you ever had an unexplained allergic reaction?</td>
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<tr>
<td>11 Cancer. If yes, please state which type.</td>
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### Wellness:

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<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>1  Do you currently have an acute systemic infection e.g. flu? If yes, please state.</td>
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<tr>
<td>2  Any disease aggravated by exercise. If yes, please state.</td>
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<td>3  Mental or physical impairment leading to decreased ability to exercise. If yes, please state.</td>
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<tr>
<td>4  Have you been sick the cold/flu more than 3 times in the last 6 months?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5  Have you ever had chest pain, dizziness, shortness of breath, excessive fatigue during exercise?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  Have you ever fainted or lost consciousness during exercise?</td>
<td></td>
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</tr>
<tr>
<td>7  Heat related illness, especially loss of consciousness in the heat?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  Mental Health Disorder (anxiety, depression, etc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9  Have you had an eating disorder?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Do you feel tired/ fatigued?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lifestyle habits:

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Have you exercised in the previous six months? If yes, how many times a week/ month?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  Do you smoke?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  Is work stressful?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4  Do you feel you are coping with the stress in your lifestyle?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5  Do you get enough sleep? State how many hours.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  Do you wake up refreshed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7  Do you have any incompletely healed or non-rehabilitated injury? If yes, please state.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  Illness requiring medical attention in the past year? If yes, please state.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9  Are you under observation by a physician for a problem? If yes, please state.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Women Only:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you have a history of irregular menstrual periods?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>How many menstrual periods have you had in the past twelve months?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Have you ever missed your period for three consecutive months or more?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Have you had a pelvic exam by an obstetrician/gynaecologist?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Have you had an abnormal Pap smear?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Have you had cervical cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Have you had cervical ulcers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Have you had amenorrhoea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Are you pregnant? If yes, how many months?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Family History:**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
<th>Family Relation (Mom, dad, sister, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High Blood Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sudden Death</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Heart Disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Heart Attack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>High Cholesterol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Marfan's syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Hereditary disease. If yes, please state.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Mental health disorder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Other. If yes, please state</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
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</tbody>
</table>
Acknowledgement and Authorisation section

Description of Condition(s)/Health Status:

As part of the process of becoming a voluntary participant for the present study, I completed the above “Medical Report” form. Recognising that my true physical condition is dependent upon an accurate medical history and a full disclosure of any symptoms, complaints, prior injuries, ailments, and/or disabilities experienced, I hereby affirm that my “Medical Report” was fully and accurately completed; that all of my present symptoms, complaints, ailments, disabilities, and/or prior injuries have been disclosed in writing to, and discussed with, a physician and that I am not suffering from any complaints, prior injuries, ailments, disabilities, conditions, or problems not so disclosed and discussed. At the time of my examination, my physician, found no contraindications for my participation in the present study. Furthermore, I consent to the use of the medical report as a sufficient screening tool to determine my entry into the study based on exclusion and inclusion criteria, that it is fair and unbiased.

Change in Health Status:

I acknowledge that I have a duty to provide the UJ Research Team with timely notice of any subsequent injuries or illnesses which might impair my ability to participate in the study, or be detrimental to my health and safety, or that of fellow participants.

Initials __________     Signature: ________________
The exercises will be explained and demonstrated by a Qualified Biokineticist. Thereafter it will be required that you please carry on with the exercises on your own. It is important to please mark down every exercise session completed, including the day, the date, the duration, the specific exercise done and the overall feeling that was felt after the session.

E.g.

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Duration</th>
<th>Exercises Done</th>
<th>Overall Feeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>01/01/01</td>
<td>15min</td>
<td>Bike</td>
<td>Fatigue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20min</td>
<td>Stretching</td>
<td>Relaxation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Duration</th>
<th>Exercises Done</th>
<th>Overall Feeling</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
## APPENDIX E

THE ACSM (2006) ABSOLUTE AND RELATIVE CONTRAINDICATIONS TO EXERCISE

<table>
<thead>
<tr>
<th>Absolute</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in resting ECG suggesting ischemia, myocardial infarction or</td>
<td>Left artery stenosis</td>
</tr>
<tr>
<td>other acute cardiac event</td>
<td></td>
</tr>
<tr>
<td>Unstable angina</td>
<td>Stenotic valvular heart disease</td>
</tr>
<tr>
<td>Uncontrolled cardiac dysrhythmias causing symptoms or hemodynamic</td>
<td>Electrolyte abnormalities</td>
</tr>
<tr>
<td>compromise</td>
<td></td>
</tr>
<tr>
<td>Aortic stenosis</td>
<td>Arterial hypertension above 200/110</td>
</tr>
<tr>
<td>Symptomatic heart failure</td>
<td>Tachy or brady</td>
</tr>
<tr>
<td>Pulmonary embolus or infarction</td>
<td>Hypertonic cardiomyopathy</td>
</tr>
<tr>
<td>Acute myocarditis or pericarditis</td>
<td>Disease aggravated by exercise</td>
</tr>
<tr>
<td>Dissecting aneurysm</td>
<td>Atrioventricular block</td>
</tr>
<tr>
<td>Acute systemic infection</td>
<td>Ventricular aneurysm</td>
</tr>
<tr>
<td></td>
<td>Uncontrolled metabolic disease</td>
</tr>
<tr>
<td></td>
<td>Chronic infectious disease</td>
</tr>
<tr>
<td></td>
<td>Mental of physical impairment leading to</td>
</tr>
<tr>
<td></td>
<td>decreased ability to exercise</td>
</tr>
</tbody>
</table>
APPENDIX F

RATING OF PERCEIVED EXERTION

15-POINT BORG SCALE

This scale is a subjective tool used to determine the intensity at which an individual is working at. Ideally the participants should be working at a level of 10 –12 on the Borg Scale.

<table>
<thead>
<tr>
<th></th>
<th>Exertion Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>No exertion at all</td>
</tr>
<tr>
<td>7</td>
<td>Extremely Light</td>
</tr>
<tr>
<td>8</td>
<td>Very Light</td>
</tr>
<tr>
<td>9</td>
<td>Light</td>
</tr>
<tr>
<td>10</td>
<td>Somewhat Hard</td>
</tr>
<tr>
<td>11</td>
<td>Hard (Heavy)</td>
</tr>
<tr>
<td>12</td>
<td>Very Hard</td>
</tr>
<tr>
<td>13</td>
<td>Extremely Hard</td>
</tr>
<tr>
<td>14</td>
<td>Maximal exertion</td>
</tr>
</tbody>
</table>

(Baechle & Earle, 2000: 501)