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# The effects of moderate aerobic exercise and satyanda yoga on long-term stress, selected cognitive and somatic measures, and learning of a motorskill in response to an acute stressor

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THE EFFECTS OF MODERATE AEROBIC EXERCISE AND

SATYANDA YOGA ON LONG-TERM STRESS, SELECTED COGNITIVE

AND SOMATIC MEASURES, AND LEARNING OF A MOTOR SKILL

IN RESPONSE TO AN ACUTE STRESSOR

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To my mother, father, grandfather

and in beloved memory of my grandmother

## ABSTRACT

The purpose of this investigation was to compare the effects of a 10 week training program of moderate aerobic exercise and satyanda yoga on long-term stress, selected cognitive and somatic measures, and learning a motor skill in response to an acute stressor.  The subjects were 44 female (mean age = 19.5yrs) undergraduate students from the University of Wollongong who were considered to be of below "average" fitness and had no formal stress management experience.  All subjects based on their scores on the Jenkins Activity Survey were categorised as Type B.  Subjects were randomly assigned to one of four groups: (1) a moderate aerobic exercise group in which subjects participated in a 10-week fitness program consisting of weight training and aerobic/floor stations; (2) a group which practised 10 weeks of satyanda yoga techniques; (3) a placebo group which met once per week for 10 weeks to attend weekly lunch time musical performances; and (4) a no stress control group which underwent initial testing without being exposed to the acute stressor, prior to and at the end of a 10 week period.

Immediately before and after the 10 week intervention, the subjects' aerobic fitness, mood state as determined by the Profile of Mood State (POMS), heart rate, blood pressure, and motor performance on the pursuit rotor apparatus in response to acute

psychological stress were assessed. The acute psychological stressor involved two components: (1) competing with a confederate for ten, 20-second trials on the pursuit rotor apparatus, and (2) experiencing bogus negative feedback rating performance as "poor" on eight of the ten trials. The control group completed the motor task without competing with a confederate or receiving bogus negative feedback.

Analyses of variance (ANOVAs) on the POMS measures showed that the moderate aerobic exercise group significantly decreased long-term cognitive levels of tension. The effects of the treatments on cognitive responses to acute stress were assessed in a series of MANCOVAs, where the change from resting to final POMS, pre and post intervention were the dependent measures and initial group differences served as the covariate. The exercise group recorded a significant decrease in confusion to the stressor after the intervention, whereas the yoga group responded with greater anger.

Not surprisingly, subjects in the moderate aerobic training condition displayed significantly better improvements in aerobic fitness than subjects in all other conditions. As a result, a series of ANOVAs revealed the aerobic group showed significantly greater reductions in absolute heart rate at rest and at recovery from stress than subjects in the other conditions. An ANCOVA where initial group differences served as the

covariate on the change from pre to post intervention baseline levels of diastolic blood pressure revealed significantly lower resting diastolic blood pressure in the exercise and yoga groups. Finally, the groups did not differ in their motor skill acquisition. These data support the contention that an aerobic component is a necessary component of an exercise regimen for improving psychological and physiological health and in coping with acute mental stress.

## ACKNOWLEDGEMENTS

# TABLE OF CONTENTS

# TABLE OF CONTENTS - Continued

# LIST OF TABLES

# LIST OF FIGURES

# CHAPTER I

## INTRODUCTION AND BACKGROUND

Western culture has become increasingly more stressful in recent years. Overcrowding, competitiveness and the ever increasing pace of the Western industrial climate are some of the factors which increase the demands and consequent stress in Western civilizations. It is thought that between 75 and 90 percent of all disease in contemporary western society is related to the body's activation of the stress mechanism (Asterita, 1985). The effect of stress on the health and well-being of the human organism has been a popular area of research, particularly in recent years.

Diseases such as coronary heart disease, stroke and cancer tend to occur more often in people who are habitually stressed than those who are not (Johnston 1989; Maier and Laudenslager, 1985; Speilberger, 1987). Although the strength of the relationship between stress and disease varies from low to moderate, Maddi, Bartone and Puccetti (1987) have found that stressful life events correlate positively and significantly with concurrent illness scores. The relationship increases in magnitude if moderating variables such as neuroticism, physical health and subjectivism are controlled. Anxiety, depression and anger are examples of common psychological manifestations of stress (Billings and Moos, 1984;

Speilberger, 1987). People who are habitually stressed need to reduce the pathological effects of their stress responses.

There has been some debate as to whether the stress-illness relationship eventuates from long periods of increased stress levels or a pattern of rapid and extreme changes between relatively low and high physiologic responses to perceiving or experiencing stress (Morell, 1989). Because investigators rarely examine both issues within a single study, the relationship between the two assessment approaches remains unknown. This controversy, nonetheless, is reflected in the manner in which responses are determined and measured (Krantz and Manuck, 1984). As such, a myriad of stress classification has eventuated. For example, Berger and Owen (1988) in their investigation of the affects of exercise upon cognitive stress responses, have classified short-term stress reduction as a more favourable mood profile attained from the Profile of Mood States (POMS), when administered before and then after a single bout of exercise. In contrast, stress of an acute nature has been described as a time-limited and short-term stressful event (Anshel, in press).

Anshel (in press) suggests that if the duration of a psychologically stressful event is long-term and persistent, this type of stress is said to be chronic. Therefore, a chronic stressor may affect long-term levels

of stress. Of note, Asterita (1985) describes the long-term physiological changes resulting from chronic stressors as chronic stress. For the purpose of clarity, long-term stress will be utilised in the present investigation to represent psychological and physiological stress responses that eventuate over extended periods.

Contemporary theories of the stress-illness relationship refer to buffers "that can decrease the likelihood of stress-related disorders either by decreasing organismic strain (e.g. physical exercise) or by neutralizing the stressful events (e.g. transformational coping)" (Maddi et al., 1987, p.840). As such, the short-term and long-term consequences of both cognitive and somatic stress responses need to be assessed.

Moderate aerobic exercise, and different relaxation programs such as Benson's Relaxation Response, progressive relaxation, and yoga are commonly used effective stress reduction techniques (Benson, 1975; Morgan and Goldston, 1987; Woolfolk and Lehrer, 1984). For example, yoga, an eastern form of stress management, has recently been found to promote a broad range of short-term, but not long-term, alterations in a positive mood state (Berger and Owen, 1988). In addition, self-report measures of general tension have indicated stress reduction due to yoga meditation (Kalayil, 1988).

Exercise participants from healthy populations regularly report short-term psychological benefits such as positive mood shifts (Berger, 1987; Berger and Owen, 1988) and decreases in state anxiety (Morgan, 1987). However, the results of investigations into the effects of exercise upon long-term stress levels have been equivocal.

Utilising the Profile of Mood States (POMS) to measure cognitive stress, Berger (1987) and Berger and Owen (1988) reported no significant reductions in long-term stress with subjects who participated in moderate aerobic exercise programs. In contrast, Iannone (1988) and Moses, Steptoe, Mathews and Edwards (1989) have reported long-term stress reductions in subjects utilising similar exercise protocols on similar stress measures. Also, after a three month follow-up to the conclusion of a range of 12 week aerobic exercise programs, Moses et al. (1989) found that moderate aerobic exercisers maintained reduced long-term stress levels as recorded on measures of perceived coping ability. Other populations such as the clinically anxious and depressed consistently report reduction in long-term stress in response to aerobic exercise programs (Fremont and Craighead, 1987).

It would be of interest to researchers to examine the factors that contribute to coping with acute stress in response to reduced long-term stress levels, and the effect of physical activity and yoga on these changes.

Roth, Bachtler and Fillingin (1989) found that administering an acute stressor during a single exercise bout limits the short term stress reduction evident after exercise. That is, a reduction in short-term stress when experienced directly after exercise is limited if an acute stressor is introduced during the exercise bout. Research, initially needs to clarify whether reductions in long-term stress levels occur at the conclusion of an exercise and/or yoga training program, in healthy subjects who are randomly assigned treatments. Further, research needs to determine if these long-term reductions provide a mechanism whereby acute stress responses are reduced, by comparing the acute stress responses of subjects before and after exercise and yoga programs.

Halahan and Moss (1987) have suggested there exists individual differences in the ability to cope with stress. Coping consists of learned behavioural responses that successfully lower stress reactions by reducing the importance of a dangerous or unpleasant condition (Lazarus and Folkman, 1984). Therefore coping represents a process that allows a person to control, reduce, or tolerate stressful demands (Anshel, in press). Typically, people less able to cope with stress express their stress responses in terms of more extreme physiological reactions (Bruning and Frew, 1987). For example, persons who cope with mental stress by suppressing their anger have been found to have elevated blood pressure (Gentry, Chesney, Gary, Hall and Harburg,

1982) and heart rate reactivity (Mills, Schneider and Dimsdale, 1989) as compared to those subjects who outwardly express their hostility.

The hostile Type A behaviour pattern represents another characteristic linked to elevated heart rate reactivity in response to a mental stressor (Felsten, Leitten and McBath, 1989). Friedman and Rosenman (1981) have described the main characteristics of the Type A individual as competitiveness, aggravation, anger, irritation and impatience. Researchers (Jones, 1988) have noted a similarity between Type A behaviours and the stereotype of the upwardly mobile, success-oriented achiever. In contrast, Type B individuals are regarded as having relatively lower tendencies towards all Type A behaviours.

Some authors have questioned the reliability of the Type A measure and related elevations in heart rate reactivity responses to mental stress (Harbin, 1989). In an attempt to find a more reliable behavioural predictor, Öhman, Nordby and Svebak (1989) have devised an Irritable and Impatient subcomponent, and a Hard-driving and Competitive subcomponent of the Type A behaviour pattern. Initial results appear to relate higher scores on the Irritable and Impatient, rather than the Hard-driving and Competitive subcomponent, with greater cardiovascular reactivity to mental stress.

The effects of stress management techniques upon behavioural indices have been seen in studies of Type A modification (Johnston, 1989). In a comparison of stress reduction techniques, Roskies, Seraganian, Oseasohn, Hanley, Collu, Martin and Smilga (1986) randomly assigned Type A men to one of three treatments; cognitive behavioural stress management, jogging or the control activity of weight training. Those who practised cognitive behavioural stress management techniques for 10 weeks significantly reduced their Type A behaviour pattern as measured by the structured interview. Those in the jogging and weight training treatments did not. However, no other stress measurement was assessed. Consequently, these treatments may have had an affect on other cognitive or physiological variables. As yet no research has assessed the effects of stress management upon the Irritable and Impatient sub-component in terms of behavioural, cognitive or physiological dependent variables.

A 12-week program of moderate aerobic exercise practised three times a week (Sherwood, Light and Blumenthal, 1989) and six weeks of selected yoga Asana and breathing exercises practised twice a day for 20 minutes per session (Kalayil, 1988; Kanade, 1990) have been found to lower resting levels of heart rate and blood pressure and, as such, may increase tolerance to mental stress (Karasek, Russell and Theorell, 1982). In particular, persons of greater cardiovascular fitness

have responded to mental stress with attenuated heart rate (Holmes and Roth, 1985; Light, Obrist, James and Strogatz, 1987; van Doornen and de Geus, 1989), systolic blood pressure (Light et al., 1987), and diastolic blood pressure (Hull, Young and Ziegler 1984; Sherwood et al., 1989). Methodological inconsistencies such as cross-sectional versus longitudinal designs, disparity in laboratory stressors employed, and differences in the definition and measurement of physical fitness limit the possible conclusions regarding variety in somatic stress responsitivity as a function of cardiovascular fitness level. More information is required as to any alterations which may occur in cognitive, somatic and motoric responses to acute stress due to increases in cardiovascular fitness utilising within-subject experimental designs.

The purposes of this study were:

(1) To compare the benefits of two behavioural techniques experienced over a ten-week period for the purpose of reducing long-term stress levels and consequent short-term responses to acute stress as measured by the Profile Of Mood States (POMS), heart rate, blood pressure, and time on target, and

(2) To examine both psychological and physiological measures of stress in an attempt to explain possible underlying mechanisms in reducing unpleasant responses to acute stress.

## Significance of the Study

Investigations concerned with stress reduction have typically compared the effectiveness of various techniques on cognitive or somatic measures of long-term stress (Berger, Friedmann and Eaton, 1988; Moses et al., 1989; Roth and Holmes, 1987; Sinyor, Golden, Steinert and Seraganian, 1986). Relatively few investigations, however, have examined the effects of decreasing long-term stress levels on consequent acute stress responses. Also, of the studies that have investigated responses to acute stress, motoric consequences to stress administration are rarely measured. For example, in a rare study in this area, Light et al. (1987) examined the effect of aerobic fitness via an exercise training program on performance in response to acute stress. No significant differences were found. Nonetheless, the simultaneous examination of cognitive, somatic, and motoric responses to acute psychological stress exposure has received only scant attention in the research literature. Therefore, the significance of the present investigation needs to be addressed in terms of cognitions, somatic responses, and consequent motor learning.

Researchers have identified a short-term positive effect on mood immediately following moderate aerobic exercise, classified as an active stress reduction technique, and Hatha yoga , a passive approach (Berger

and Owen, 1988). However, the effect of extended exercise programs on long-term psychological stress has been mixed. Berger and Owen (1983) found no evidence of positive mood alteration or long-term cognitive stress reduction in swimmers completing a 10-week moderate aerobic exercise program. Nor did the authors find significant benefits in participating in a 12-week Hatha yoga class (Berger and Owen, 1988). However, Berger, Friedmann and Eaton (1988) found a significant reduction in long-term cognitive stress in college students after completing a 12-week moderate aerobic exercise program, although no causal link between exercise and long-term cognitive stress reduction was possible due to similar reductions recorded for wait-list controls.

More recently, several authors have found positive long term mood alterations in working adults who participated in a 10 week training program of moderate aerobic exercise (Moses et al., 1989; Simons and Birkimer, 1988). No such reductions were recorded for the other treatment group of intense aerobic training or the wait list control group. Nonetheless, improved cardiovascular fitness still represents one of the necessary criteria of moderate aerobic exercise to promote positive mood alterations (Berger and Owen, 1988; Moses et al., 1989). More attention is warranted by researches as to whether moderate forms of aerobic exercise and passive forms of stress reduction such as yoga, produce long-term stress reductions.

In particular, apparently absent from the literature is the effect of extended active (aerobic exercise) and passive (yoga) stress reduction programs on the ability to cope with acute stress. Roth et al. (1989) have found that administering an acute stressor during a single exercise bout limits the short term stress reduction evident after exercise. That is, a reduction in short term stress, when experienced directly after exercise, is limited if an acute stressor is introduced during the exercise bout. Further research is required to determine whether long-term stress reduction, as measured by alterations in resting levels of mood state, occurs after prolonged programs of moderate aerobic exercise and yoga. Secondly, the effect of reducing long-term stress levels on coping with acute cognitive stress also needs further examination.

Reduced somatic stress responses to acute psychological stress have been recorded in persons of greater cardiovascular fitness (Holmes and Roth, 1985; van Doornen and de Geus, 1989). Several methodological design limitations have been evident in previous research investigating the relationship between cardiovascular fitness and somatic stress responses. These limitations have included the non-use of control groups, a lack of random assignment to groups and between-groups designs rather than treatment manipulations with repeated measures. The present investigation, as discussed later, has controlled for these limitations by randomly

assigning subjects of low fitness and with no or limited past experience using stress reduction techniques, and included control and placebo groups.

Finally, acute psychological stressors have been shown to increase arousal to an optimal level which in turn, appears to enhance the learning of skills. This response has been discussed in Consolidation Theory (Walker and Tarte, 1963). Walker and Tarte (1963) suggest that the neural memory trace established by practise will be more "intense" under high arousal, and, since this neural trace is essential for the production of a structural modification in the nervous system (represented as long-term memory) the higher arousal during the practise period will produce greater long-term memory. If cardiovascular fitness attenuates somatic responses to acute cognitive stress, it may also limit any favourable effect on learning a motor skill. Consequently, an investigation to assess the effect of improved cardiovascular fitness on psychological (e.g., mood) and somatic responses (e.g., heart rate and blood pressure) to acute cognitive stress, and the manner in which these responses affect motor learning was warranted.

## Statement of the Problem

The purpose of the present study was to investigate the effects of a 10-week program in moderate aerobic exercise and yoga, as opposed to placebo and no-stress

control groups in coping with acute psychological stress. Cognitive (Profile of Mood States), somatic (heart rate, and systolic and diastolic blood pressure), and motoric responses to acute stress were recorded. Specifically, alterations in baseline measures of mood state as recorded by a psychological inventory, the Profile of Mood States (POMS) were assessed after participation in a 10-week training program of moderate aerobic exercise and a 10-week yoga program to determine the effects of an acute cognitive stressor on mood state. Similarly, any alterations in baseline levels of cardiovascular fitness were assessed to determine the extent to which aerobic exercise, experienced three times per week for 10 weeks, affected somatic responses and learning a motor skill in response to acute mental stress. Finally, correlations between cognitive, somatic and motoric responses before and after various intervention programs, between selected physiological responses, and between chronic and acute stress responses were determined.

## Research Hypotheses

The following directional hypotheses were examined:

1. The aerobic exercise group will experience a significant decrease in long-term stress at the conclusion of a 10-week exercise program when compared to stress levels prior to the program, as opposed to the placebo and no-treatment (control) groups.

A perusal of the literature concerned with exercise-related reductions in long-term stress presents conflicting documentation as to the relationships between exercise and long-term stress levels. Berger and Owen (1983, 1988) have repeatedly found no significant changes in long-term stress in response to various forms of aerobic activity. Iannone (1988), however, found lower levels of long-term stress across a broad range of mood states in subjects participating in morning and evening aerobic classes. At the conclusion of a 10-week stress reduction program, Moses et al. (1989) found reductions in long-term stress levels as measured by the tension and confusion subscales of the Profile of Mood States (POMS) in moderate, as opposed to intense, aerobic exercisers only. Also, three months after the conclusion of the 10-week stress reduction program, only the moderate aerobic exercise condition showed significantly lower deficits in perceived coping as measured by a perceived coping ability and physical well-being scale (Moses et al., 1989). Furthermore, 12-week exercise training programs of aerobic dance and jogging have been found to decrease stress levels as measured by the POMS at three month followup (Simons and Birkimer, 1988). Consequently, moderate aerobic exercisers are predicted to lower their long-term stress levels as opposed to placebo and no treatment (control) groups.

2. At the conclusion of the 10-week treatment period subjects from the aerobic exercise group will report a significantly reduced psychological response to a cognitive acute stressor than the placebo groups.

Roth et al. (1989) found that administering an acute stressor during a single exercise bout limits a reduction in short term stress after exercise. That is, the reductions in short term stress previously recorded directly after exercise (Berger and Owen, 1988) may be limited if the acute stressor is introduced during the exercise bout. However, levels in long-term stress may be improved by moderate aerobic exercise. If so, responses to cognitive acute stress will more likely be reduced to a significantly greater extent after completing a moderate aerobic exercise program in contrast to pre-program responses.

3. The Satyanda yoga group will experience a significant decrease in long-term stress at the conclusion of the 10-week yoga program as compared to the placebo and no treatment (control) groups.

A perusal of the literature investigating the stress reduction benefits of yoga reveals only limited examination of this area. Kalayil (1988) found yoga meditation reduced state anxiety significantly more than a "catnap" and a control group which read magazines. A broad range of short-term, but not long-term, positive alterations in mood

have also been reported after experiencing Hatha yoga sessions (Berger and Owen, 1988). Berger, Friedmann and Eaton (1988), however, have found marked reductions in long-term stress in subjects practising Benson's Relaxation Response as well as no-treatment controls. The similarity between Hatha yoga and Benson's Relaxation Response has been noted (Berger and Owen, 1988). Satyanda yoga however differs from Hatha Yoga as it concentrates more upon the use of yoga nidra a systematic method of inducing physical, mental and emotional relaxation (Saraswati, 1984). As such, it is predicted long-term reductions in stress will occur if the duration of the training program is sufficient (Stroebel, 1982; cited in Berger and Owen, 1988).

4.  At the conclusion of the 10 week treatment period subjects from the Satyanda yoga group will report significantly lower cognitive acute stress than the placebo group.

    Any deleterious effects of long-term and, consequently, short-term stress levels should be reduced after completing the Satyanda yoga treatment in contrast to pre-program responses.

5.  At the conclusion of a 10-week intervention period, the aerobic exercise treatment will result in significantly lower heart rate and blood pressure in

response to an acute psychological stressor, in contrast to the subjects who do not engage in aerobic exercise.

Documentation exists to suggest that somatic responses are reduced following exposure to acute psychological stressors in persons of greater cardiovascular fitness. In particular, comparisons between persons with extreme high and low cardiovascular fitness has revealed lower heart rate (Holmes and Roth, 1985; Light, et al., 1987; van Doornen and de Geus, 1989) systolic blood pressure (Light, et al., 1987) and diastolic blood pressure (Hull et al., 1984) following exposure to acute psychological stress.

6. At the conclusion of a 10-week treatment period, learning a motor skill, as measured by time-on-target on a pursuit rotor apparatus, will be significantly poorer for the moderate aerobic exercise group than the other groups in response to acute stress.

Excessive arousal has been strongly related to increases in motor learning (Consolidation theory) (Walker and Tarte, 1963). If increments in aerobic fitness reduce somatic responses to acute stress, then arousal level following acute stress administration will also be reduced. Thus, moderate aerobic exercise promotes cardiovascular fitness which, in turn, reduces somatic acute stress responses (Holmes and Roth, 1988). Performing any

given motor task requires an optimal level of arousal (Landers and Boutcher, 1986). Thus, it is thought that aerobically fit subjects will respond to acute stress with lower than optimal arousal for the criterion task and, therefore, perform more poorly than their less fit counterparts.

7. At the conclusion of a 10-week treatment period, the Satyanda yoga and placebo treatments will not alter heart rate and blood pressure in response to an acute psychological stressor.

The limited documentation investigating the stress relief benefits of the various forms of yoga has primarily focused upon the cognitive aspects as opposed to the somatic effects of this passive form of relaxation. Hatha yoga, the active style of yoga, has previously been regarded as not involving a level of physical activity at sufficient intensity to promote aerobic capacity (Berger and Owen, 1988). Satyanda yoga concentrates upon the practise of yoga nidra meditation and can consequently be regarded as even less active than Hatha yoga. Furthermore, in the present investigation the Satyanda yoga group was expected to practise only the active component on a weekly basis. These physical exercises were then to be interspersed with stretching routines. Consequently, the Satyanda yoga group was not

expected to increase in cardiovascular fitness. As such, their somatic acute stress responses were predicted not to differ from the placebo group.

8. At the conclusion of a 10-week treatment period, motor learning of the Satyanda yoga group will be similar to the placebo group.

Because the cardiovascular fitness level of the Satyanda yoga subjects is not expected to improve, the consequent arousal-motor learning relationships predicted of the moderate aerobic exercise group were not predicted to eventuate for the Satyanda yoga subjects.

## Operational Definitions of Terms

**Stress** - when an organism is confronted with a challenge, constraint, or demand (stressor) at a physical, biochemical, psychological, emotional or behavioural level in which a return to baseline does not immediately occur when the stressor is removed.

**Acute cognitive stressor** - this is defined as competing against a confederate at a motor task which requires ten, 20 second trials on a pursuit rotor apparatus and irrespective of performance receiving bogus negative feedback after eight of the ten trials.

**Acute somatic stress responses** - are represented by heart rate (beats per minute), change score heart rate (beats per minute) and blood pressure (mmHg) readings prior, during and after the administration of an acute cognitive stressor. Heart rate change scores were calculated as: Change score = level prior, during or after minus baseline values.

**Acute cognitive stress responses** - are represented by Profile of Mood State (POMS) mood scores prior, during and after the administration of an acute cognitive stressor. The POMS assesses mood states in the form of six subfactors; tension, depression, anger, vigor, fatigue and confusion.

**Long-term cognitive stress** - is represented by the change in resting POMS scores when compared prior to and at the conclusion of a ten week treatment program. Resting POMS scores were measured after three minutes of rest prior to the administration of an acute cognitive stressor.

**Motor performance** - the degree of time-on-target on the criterion task recorded during a 20-second period at a speed of 50 revolutions per minute on the pursuit rotor apparatus.

**Type A and B behaviour pattern** - is represented by a score in the upper or lower third percentiles respectively of overall behaviour score tabulated from the Jenkins Activity Survey.

**Low Aerobic Fitness** - an aerobic fitness score expressed in watts/kg which is equivalent to, or below, the mean of the "Fair" section of the aerobic portion of the Tri-level fitness assessment.

**Arousal** - is represented by heart rate (bpm) and blood pressure (mmHg) levels recorded prior, during and after acute cognitive stressor administration, pre and post 10 week treatment intervention.

## Assumptions

It was assumed that:

1. The physical health of all subjects were of adequate standard to participate in a moderate aerobic exercise program. All subjects signed a consent form confirming adequate physical health (see Appendix A).

2. All subjects were free of any psychological abnormalities that may have biased their cognitive responses to acute stress. All resting group mean mood state scores were within the normal range as measured by the POMS, prior to the 10 week intervention program.

3. Competition in combination with bogus negative feedback was used to induce heightened acute stress responses which was evident in both psychological and somatic measures.

4. The pursuit rotor motor task was a novel skill to all subjects.

5. Subjects from each group did not participate in any other form of stress management while engaged in the investigation.

## Delimitations of the Study

Specifically, the delimitations of the study may be listed as follows:

(1) In view of the sample which participated in the experiment, inferences must be confined to the representative population (e.g., female under-graduate university students, ranging in age from 18 to 24 years, with low aerobic fitness).

(2) The fine, closed and continual nature of the motor task used in the present investigation was not considered representative of all motor tasks.

(3) The group overall behaviour scores and Irritable and Impatient subscores indicated all groups fit or approximately fit the profile of Type B behaviours and were low in Impatience (Öhman et al., 1989), respectively; i.e. the groups displayed behaviours relatively absent of aggravation, anger, irritation and impatience (Herbertt, 1988). This may have undermined the effects of an environmentally induced stressor, due to past research indicating that Type B's (Friedmann and Rosenman, 1981), and more

recently subjects scoring low in Impatience (Öhman et al., 1989) respond relatively less negatively to an acute psychological stressor.

(4) Individual differences amongst the subjects were evident in their cognitive and somatic responses to acute stress. For example, not only does mental stress manifest itself in many somatic forms, but these somatic responses also depend primarily upon individual subjects cognitive interpretation of the acute stressor. As such the dependent variables utilised to measure stress responses may not have measured all stress manifestations.

(5) The present investigation utilised competition and bogus negative feedback as cognitive stressors which may also have affected subjects to varying degrees. However, subject competitiveness was analysed to assess any group differences that may have occurred due to this variable and no significant differences were evident between groups.

(6) Although exhibiting greater reliability than previous submaximal measures of cardiovascular fitness, the method of obtaining data on the subject's physical capacity was based on submaximal measures rather than maximal effort.

(7) Group differences existed as to how regularly the subjects convened in a group setting. The art-placebo and Satyanda yoga groups met once a week, with only the Satyanda yoga subjects requiring home practise. The aerobic exercise group however met at least three times weekly in a group setting. Although total practise time was equivalent between the aerobic exercise and Satyanda yoga groups, both groups experienced their respective treatments for a longer weekly period than the placebo group. Consequently, treatment frequency may represent an intervening variable.

## CHAPTER II

## REVIEW OF LITERATURE

Despite a decline in recent years, coronary heart disease remains the single most frequent cause of death in Australia, particularly in the middle or older age groups (Roberts and Thompson, 1988). In 1979, almost 31,000 people died from heart attack and one in every five Australian males was predicted to suffer from an attack by the time they finished their working life (Roberts, 1982). Six years on and in 1985, diseases of the heart were still responsible for one third of all deaths and heart attacks alone were responsible for more deaths than any other single cause (Roberts and Thompson, 1988).

The causes of coronary heart disease (CHD) and its prevention, are complex and involve many biological, environmental, psychological and behavioural factors (Johnston, 1989). Increasing evidence has supported the notion that coronary heart disease is often the result of direct and indirect effects of mental stress (Asterita, 1985; Johnston, 1989). Psychological manifestations of mental stress include anger, depression and anxiety (Speilberger, 1987). It appears that the management of stress may be the most effective measure in preventing CHD and other illnesses.

Although it would appear stress is a pervasive risk factor to physical and mental health (Johnston, 1989), there exists debate as to whether the relationship between stress and illness eventuates from consistent levels of long-term stress, or the consequences of repeated exposure to short term stress (Morell, 1989). Because investigators rarely examine both issues within one study, the relationship between the two assessment approaches remains virtually unknown. In addition, there exists associated methodological differences in the determination of stress responses (Krantz and Manuck, 1984). These methodological differences have resulted in the assessment of the effects of chronic or acute stressors upon a variety of dependent variables such as cardiovascular reactivity, behaviour, mood and motor learning. The extent to which males and females differ concerning the effects of various stress management interventions upon mental and physical well-being is another area of needed research. In an attempt to examine these issues and critique the methodological variations, this review is concerned with the following sections: (1) characteristics of stress, (2) stress and mood, (3) stress, Type A behaviour and coronary heart disease (4) stress and motor learning, (5) sex differences in the stress response, (6) exercise and the stress response, (7) stress management interventions and a concluding (8) summary.

## Characteristics of Stress

Hans Selye (1956) was among the first to describe stress as a multidimensional experience with physiological, behavioural and psychological consequences within a person in response to a stimulus perceived as a threat. More recently, Asterita (1985) has defined a state of stress to be "when any or some of an organisms constitutent parts, whether physical, biochemical, mental, emotional, behavioural, etc. are confronted with a challenge, constraint or demand to do or be at such a level, that a return to baseline doesn't immediately occur when the stressor is removed (p.6)". The change in baseline levels cause a shift in the homeostasis of the organism. Long-term homeostatic changes may eventually lead to an alteration or breakdown of any of the constituent parts within the organism.

Selye (1976) presents two models in explaining the organism's stress response. The generality model suggested a nonspecific response of the body to any noxious stimuli. In contrast, the specificity model, predicts that stressful events may lead to distinctive modes of reactivity. The stress response, therefore, is more than a result of the stimulus under consideration. It is also a result of the person's cognitive interpretation of the stimulus (primary appraisal) and consequent assessment as to whether he or she has the adequate resources to cope (secondary appraisal) (Lazarus

and Folkman 1984; Seyle, 1976). Consequently, responses vary from individual to individual; what may elicit a stress response in one person may not in another (Pierce and Stone, 1986). Furthermore, individuals vary in the way they react to stress. For example, people who suppress their anger in response to stress tend to react with greater physiological reactivity than people who outwardly express their anger (Mills et al., 1989). In an attempt to explain these differences Selye (1976) distinguished stressors from stress, the latter representing an adaptive response of the body to restore normal functioning.

## Stressors

Selye (1976) used the term "stressor" to describe those events that may disturb normal homeostasis. He contended that these events do not have to be unpleasant in order to disrupt homeostatic balance. Stress can have positive or negative consequences upon the body, referred to as eustress and distress, respectively. Selye (1976) suggests it is immaterial whether the stressor is pleasant or unpleasant; the intensity of the demand for readjustment is the criteria which effects the stress-illness relationship. Distress is characterized by an excessive accumulation of negative consequences, such that greater homeostatic imbalance occurs relative to the few negative consequences eventuating from eustress. Consequently, elevated resting cardiovascular measures in

response to distress would be greater than similar responses to eustress. These consequences may become manifest particularly in the long-term rather than in the short term (Asterita, 1985).

Crews and Landers (1987), in their meta-analytical review on the effects of cardiovascular fitness on stress responses, included the following examples of stressors: (a) cognitive tasks such as solving timed arithmetic problems, (b) passive response tasks such as viewing films of industrial accidents or medical operations, (c) active physical performance tasks, and (d) passive physical performance tasks such as holding a limb immersed in ice water. Crews and Landers (1987) investigation will be elaborated upon later in this review. Researchers have found that subjects' reactivity to the last three of these stressors is generalized across eleven cardiovascular dependent variables (McKinney, Miner, Ruddel, McIlvain, Witte, Buell, Eliot and Grant, 1985). McKinney et al. (1985) found absolute stress responses, as measured by such dependent variables as blood pressure, heart rate and stroke volume were correlated across three stress tasks; playing a video game, performing a choice reaction-time test, and performing a cold-pressor test.

McKinney et al. (1985) found support for Selye's (1976) dual model conceptualisation of the stress response. Evidence of stress response generalizability

was evident as the three stressors led to cardiovascular change in at least eight of the eleven dependent variables measured. However, the cold-pressor test alone, increased total systemic resistance. As such a particular stressful event led to reactions in a distinctive mode of reactivity, and the specificity model of stress responsitivity was also supported.

The stress response itself is comprised of over 1,400 physiochemical changes (Wilson and Schneider, 1981). All of these changes can be activated to varying degrees and at different periods. Alterations in stressor intensity, that is, low, moderate or high intensity stress levels, and short-term versus long-term stress, does not necessarily result in similar responses between subjects (Carroll, Turner and Rogers, 1987).

## Stress Intensity

Stressor intensity is difficult to operationally define due to the individuality in stress responses and the range of dependent variables measured in response to stress. For example stress responses have been recorded on a variety of physiological, psychological, behavioural and motoric measures. Nonetheless, Crews and Landers (1987) attempted to classify stress intensity. Heart rate (HR) was recorded in all of the investigations they reviewed. An increase in HR above initial values of less than or greater than 30bpm was classified as low or high

stress intensity, respectively. However, these classifications of stress intensity have limitations in internal validity. For example differences in personality, (Felsten et al., 1989), cardiovascular fitness (van Doornen and de Geus, 1989), and response measurement (Crews and Landers, 1987) may have affected heart rate reactivity. Divisions between stressors based upon stress duration allow more operationally accessible definitions.

## Long-Term Versus Short-term Stress

Berger and Owen (1988) in their investigation of the affects of exercise upon cognitive stress responses, defined long-term stress reduction as a decrease in Profile of Mood State (POMS) scores when assessed directly before an exercise bout at the initiation of a two month exercise program, and then again, directly prior to exercise at the conclusion of the exercise program. The terms chronic and long-term stress have been used interchangeably within the literature in referring to psychological and physiological responses to stress (Asterita, 1985). Typical effects of chronic stressors include burnout, demotivation and in certain situations even sexism (Chambers, 1983) as well as disease states such as coronary heart disease, cancer, and stroke, as previously mentioned (Johnston, 1989; Asterita, 1985).

The assessment of short-term stress has been completed by Berger and Owen (1988) and has been defined as the mood scores attained from the POMS, when administered before and then directly after a single bout of exercise. Stress of an acute nature, has been described as time-limited and short-term (Anshel, in press). Therefore an acute stressor may affect short-term levels of stress. When sources of stress are acute, various psychophysiological and cognitive factors can be negatively affected (Anshel, in press).

## Physiological Dimensions of Stress

Selye (1976) noted the nonspecific response of the body to any noxious stimulus. The most rapid "non-specific" physiological response to stress occurs with the activation of the autonomic nervous system (sympathetic arousal), also known as the "fight or flight" response. This is purely a neural pathway, culminating in neural innovation of end-organs. The neuroendocrine activation (sympathetic stimulation of the adrenal medulla) contributes to the intermediate effects of stress. Activation of the neuroendocrine axes follows, which comprises several endocrine glands and accounts for the most prolonged and long-term phase of the stress response. However, Asterita (1985) warns overlap between the various neural and endocrine mechanisms may occur. The physiological consequences of the activation of these pathways can be detected by

measuring end-organ responses such as heart rate, respiration rate and blood pressure levels. Other physiological measures include electromyography, temperature level, plethysmography, electrodermal activity and electroencephalography (Asterita, 1985). One physiological measure which has gained particular attention is cardiovascular reactivity.

Changes in the cardiovascular system in response to mental stress can be measured by a range of cardiovascular dependent variables such as heart rate, blood pressure and cardiac output (Obrist, 1976). Changes in any of these hemodynamic variables in response to mental stress is collectively labelled cardiovascular reactivity to mental stress (McKinney et al., 1985). Challenging tasks that necessitate active coping have been observed to produce cardiovascular activity in excess of metabolic demand (Sherwood, Allen, Obrist and Langer, 1986). The comparison of cardiac output with directly measured oxygen uptake has resulted in the measurement of metabolically excessive heart rate reactivity and systolic blood pressure, but only minor increases in diastolic blood pressure (Light, 1981) to psychologically stressful tasks. In addition, Sherwood et al. (1986) demonstrated that beta-adrenergic blockade only partially diminished the tachycardia to exercise, whereas the tachycardia to psychological stressors was entirely abolished by the blockade. These findings

demonstrate the sympathetic activation of the cardiac mental stress response. However several factors have been found to moderate HR reactivity.

For example, Light (1981) found the magnitude and duration of HR reactivity to mental stress was modulated by the environmental factor of task difficulty. If the stress-inducing task requirements were either very easy or impossible to meet, subjects showed relatively large heart rate and blood pressure responses at onset of the task, but later these responses declined more rapidly than those of subjects assigned a difficult but not impossible performance criterion. This finding was attributed to the fact that both too easy and too difficult conditions eventually discourage the subject from exerting maximum effort in coping (Light, 1981). The importance of cognitions and appraisal in mediating and influencing HR stress responses has also been emphasised (Mills et al., 1989). Appraisal of both internal physical and psychological responses may (either positively or negatively) influence subsequent HR responses (Singer and Cook, 1988).

Performance of mental arithmetic, a commonly employed psychosocial stressor, has reliably generated marked cardiovascular change (Turner and Carroll, 1985; Seraganian, Hanley, Hollander, Roskies, Smilga, Martin, Collu and Oseasohn, 1985). In addition to the psychological challenge that such tasks pose, a certain

degree of physical effort may be evident in simply completing the desired task. Brown, Szabo and Seraganian (1988), tested the assertion that a portion of the HR response during performance reflected the physical effort expended. These authors utilised a psychological task which consisted of a set of mental arithmetic problems for which verbal answers were requested. The physical task mimicked the speech demands of the psychological task but required no arithmetic processing. When the physical factor of performing the task was parcelled out from the total HR response, an appreciable residual HR remained. The residual HR was proposed to be more indicative of psychological task demand. The authors concluded that both physical and psychological factors contribute to changes in heart rate as generated by the stressful performance of mental arithmetic.

Other dependent variables have been utilised to assess physiological (somatic) responses to stress. These variables have included systolic and diastolic blood pressure (Light et al., 1987), cardiac output and stroke volume (van Doornen and de Geus, 1989), skin responses (Keller and Seraganian, 1984; Plante and Karpowitz, 1987), hormonal and endocrine responses (Asterita, 1985), electromyography recordings (de Vries, 1981), and electroencephalographic (Boutcher and Landers, 1988). Different portions of the stress response have been quantified from these measures such as (a) changes from initial values to stress response, (b) time to

recovery or a designated time to recovery, and (c) measures indicating absolute stress response and recovery (Crews and Landers, 1987). Light (1981) in her assessment of cardiovascular reactivity to coping with acute stress, found some individuals consistently showed higher HR and systolic blood pressure increases than others. These more reactive individuals were not significantly different from less reactive subjects in resting HR levels, assessed in a doctor's office or when relaxed. However, high reactors showed increases in heart rate and systolic blood pressure from relaxation to pre-stress while low reactors did not. Light (1981) concluded that using pre-stress levels as a baseline may eliminate a substantial part of the individual differences which may occur in response to stress. This assertion was further supported when McKinney's et al. (1985) assessment of 11 cardiovascular dependent variables during a resting baseline and during acute stress revealed, absolute levels showed greater test-retest reliability than change scores, derived by subtracting the initial resting baseline value from the stress-task value.

Recent investigations comparing the cardiovascular responses to acute stress of persons varying in aerobic fitness, have primarily utilised change scores (Holmes and Roth, 1985; Sinyor et al., 1986; van Doornen and de Geus, 1989). The rationale for such adjustment has been attributed to significant differences in resting levels

of cardiovascular measures in persons ranging in aerobic fitness (Holmes and Roth, 1985). It would appear that the assessment of both absolute and change scores in response to acute psychological stress is required when investigating the relationship between cardiovascular fitness and acute stress responses. Absolute scores are primarily utilised when assessing psychological responses to stress (Berger, Friedmann and Eaton, 1988).

## Cognitive Responses to Stress

As well as affecting numerous physiological processes, mental stress has also been found to have a detrimental effect upon psychological factors such as anxiety, arousal, emotion, mood and behaviour. Although at times used interchangeably (Landers and Boutcher, 1986) the stress literature distinguishes between stress, anxiety and arousal. As an overview, stress primarily represents an external, environmental criterion which may be pleasant or unpleasant but causes internal, physiological and cognitive changes. The alterations in resting physiological levels are primarily referred to as arousal. Anxiety, relates primarily to an internal personal criterion which has negative consequences physiologically (such as feelings of nausea) and cognitively (such as difficulty in concentration) (Pargman, 1986). Various attempts have been made to assess the relationship between stress, anxiety, arousal and emotion.

## Stress and Anxiety

Until recently the distinction between trait and state anxiety presented by Spielberger (1966; cited in Roberts, Spink and Pemberton, 1986) has gained wide recognition among researchers. Spielberger proposed state anxiety as an immediate emotional state characterized by apprehension and tension. Trait anxiety was defined as a predisposition to perceive certain situations as threatening and responding to them with varying levels of state anxiety. Martens, Burton, Vealey, Bump and Smith (1983) then separated state anxiety into two major components, self-reported cognitive anxiety, and somatic anxiety. Cognitive anxiety represents the mental component of anxiety caused by negative expectations about success, whereas somatic anxiety, is a physiological component directly related to autonomic arousal (Burton, 1988).

In an initial attempt to measure different components of anxiety, Schwartz, Davidson and Goleman (1978) developed the Cognitive-Somatic Anxiety Questionnaire. The scale was used to classify subjects as reacting to stress in either somatic or cognitive modes. The authors hypothesised that different treatments are necessary in the minimalization of cognitive versus somatic anxiety responses to stress.

For example, physical exercise may result in reductions primarily in somatic anxiety with less effect on cognitive anxiety. Recently, a number of studies have been concerned with comparing the effects of treatments designed to alter the somatic and cognitive symptoms of anxiety. The results of these investigations have been equivocal (Schwartz et al., 1978; Lehrer and Woolfolk, 1984; Long, 1984). Long (1984) compared the effectiveness of aerobic conditioning (10 weeks of jogging, three times weekly) with stress innoculation training (10 weeks of therapy, one-and-a-half hours per week) and a wait list control in the reduction of anxiety for 73 chronically stressed community residents. The Cognitive-Somatic Anxiety Questionnaire (Schwartz et al., 1978) was used to assess differential treatment effectiveness. Long (1984) found that individuals classified as either highly cognitive or somatic did not respond differently to treatments considered most effective for that mode i.e. "somatic" subjects who respond to stress primarily with somatic anxiety reactions, did not record greater anxiety reductions from a stress management program which improved the efficiency of the physiological coping system. Conversely, "cognitive" subjects did not respond with greater anxiety reductions from the cognitively based stress management program.

Nevertheless, "cognitive" subjects, regardless of treatment, reduced state anxiety significantly ($p < 0.006$) from pre to post testing as compared to the "somatic"

subjects. The "somatic" subjects, however, continued to reduce their responses to stress (as measured by state and trait anxiety) from post to follow up, while the cognitive subjects either maintained (trait) or increased (state) their self-reported anxiety levels.

Morris, Davis and Hutchings (1981) propose somatic anxiety or emotionality may be constructed as either unconditioned responses to stimuli that naturally elicit bodily arousal, and/or a set of conditioned bodily reactions to stimuli that vary among individuals according to their conditioning histories. In contrast, cognitive responses are conceived as varying according to social learning history, past experiences and environmental circumstances. Consequently, as Finger and Galassi (1977) have noted, cognitive stress responses will be more readily modified, as compared to somatic responses, which may represent unconditioned stress reactions and as such, will change slower.

Martens et al. (1983) have developed a sport-specific, multidimensional state anxiety inventory called the Competitive State Anxiety Inventory-2 (CSAI-2). The CSAI-2 independently measures somatic and cognitive components of state anxiety (Martens et al., 1983). Karteroliotis and Gill (1987) attempted to determine whether direct measures of physiological arousal (heart rate and blood pressure) were related to somatic anxiety scores on the CSAI-2. The 41 male subjects utilised in

the study were required to compete against a confederate while performing a motor task for 10 trials. Heart rate and blood pressure measures were recorded prior to, during and after competition. The CSAI-2 was completed by subjects whenever arousal measures were assessed. The results indicated that heart rate and blood pressure did not increase significantly from baseline to pre-competition. However, somatic anxiety did. The moderate relationship (Mean r = 0.50) between cognitive and somatic anxiety confirmed the non-significant relationship between psychological and physiological anxiety measures in response to stress. With respect to measures of well being, anxiety represents only one of several types of mood states.

## Stress and Mood

The effects of stress on overall mental health and well-being has been assessed in previous studies. A person's mood in response to stress has received considerable attention (Berger and Owen, 1988; Moses et al., 1989). Mood has been measured recently on the Profile of Mood States (POMS) (McNair, Lorr and Droppleman, 1971).

The POMS represents the refinement of a total of 100 different adjective scales (McNair et al., 1971). It consists of 65 five-point adjective rating scales and has

been factor analysed into six subscales: tension/anxiety, depression/dejection, anger/hostility, vigor/activity, fatigue/inertia and confusion/bewilderment. The questionnaire was originally intended as measuring mood over a one-week rating period. To meet the demands of particular investigations, shorter time sets have been utilised, such as "RIGHT NOW" (Berger and Owen, 1988). The factor structure of the POMS has not been shown to be significantly altered by a "RIGHT NOW" rating period (McNair et al., 1971).

The POMS has been used in several investigations to quantify cognitive stress responses (Berger, Friedmann and Eaton, 1988; Berger and Owen, 1988). It has also been utilised in combination with perceived coping ability and physical well-being scales to assess overall psychological well-being (Moses, et al., 1989).

The POMS has been utilised in several investigations to quantify cognitive stress responses, particularly to assess the effectiveness of various stress reduction techniques (Berger, Friedmann and Eaton 1988). Short-term stress alterations in response to stress management techniques have been assessed by administering the POMS directly before or at times, during (Steptoe and Bolton, 1988) and directly after a stress management session (Berger and Owen, 1983). Benson's Relaxation Response (Berger, Friedmann and Eaton, 1988), aerobic exercise (Berger, Friedmann and Eaton, 1988), massage (Weinberg,

Jackson and Kolodny, 1988), Tai Chi (Jin, 1989) and Yoga (Berger and Owen, 1988) represent some of the stress management techniques whose short-term stress relief consequences have been assessed, by way of the POMS. Results indicated all the techniques except exercise reduced tension, depression, anger, fatigue and confusion subcomponent scores. Exercise reduced tension, depression and anger scores only (Berger, Friedmann and Eaton, 1988).

The POMS has also been utilised to measure the long-term cognitive stress reduction benefits attributable to a stress management program of several weeks duration (usually ranging from six to twelve weeks). Long-term stress reduction is typically assessed with the POMS by tabulating a resting mood state profile prior to the initiation of the program and then rerecording resting mood state levels at the program's conclusion (Berger and Owen, 1988).

The long-term cognitive stress reduction benefits of extended programs of Benson's Relaxation Response (Berger, Friedmann and Eaton, 1988) aerobic exercise (Iaonne, 1988; Steptoe et al., 1989) and yoga (Berger and Owen, 1988) have also been assessed. Long-term stress reduction is not as consistent across stress management techniques as short-term stress minimalization is (Berger and Owen, 1988). However, moderate aerobic exercise at least has been found to decrease long-term stress levels

as recorded by the tension and confusion subscales (Moses et al., 1989). Behavioural measurements that evaluate the effects of stress upon behaviour have been dominated by the quantification of the Type A behaviour pattern.

## Stress, Type A Behaviour and Coronary Heart Disease

The Type A pattern of behaviour has been implicated as a risk factor associated with a significantly increased incidence of coronary heart disease in a number of prospective (Rosenman, Brand, Jenkins, Friedman, Strauss and Wurm, 1975) and retrospective studies (Jenkins, 1976). Friedman and Rosenman (1981) have described the main characteristics of the Type A individual as aggravation, irritation, anger and impatience. Researchers believe these characteristics arise from the Type A person's aggressive involvement in a long-term, incessant struggle to achieve more and more in less and less time (Herbertt, 1988). The similarity of this pattern with the stereotype of the upwardly mobile success oriented achiever has been noted (Jones, 1988). Finally, these Type A individuals "also frequently harbour a free-floating hostility that is often covert and usually well rationalised" (Friedman et al., 1981, p.21). In contrast, Type B individuals are usually described as possessing a relative absence of the above listed characteristics (Herbertt, 1988). Instead, Type B's are considered relatively more relaxed (Jones, 1988).

As a result of the research linking Type A behaviour and coronary heart disease (CHD) (e.g. Jenkins, 1976), an independent review panel (The Review Panel, 1981) formally recognized Type A behaviour as a risk factor for coronary heart disease. More recently, however, a growing body of research has questioned the validity of the relationship between Type A behaviour and CHD. Ragland and Brand (1988) found that subsequent coronary mortality in patients who have already suffered an initial coronary event is significantly lower among Type A than Type B patients. These authors concluded that an intervention to change Type A behaviour is not justified for the purposes of preventing another attack after an initial CHD event.

In an attempt to explain these anomalies, Dimsdale (1988) suggested that the use of various diagnostic criteria for evaluating Type A behaviour may not have been sufficiently standardized. The revised Structured Interview (SI) (Friedman et al., 1981) is considered as "a kind of gold standard" (Dimsdale, 1988). However, the SI has limitations in cost and can take up to 30 minutes to complete and as such other self-report measures of Type A behaviour have been developed. The most widely used of these is the Jenkins Activity Scale for Health Prediction (Jenkins, Rosenman and Friedman, 1967).

The JAS Type A scale has been shown to have a 72% agreement with the SI (Zyzanski and Jenkins, 1970) and is significantly related to CHD risk (Jenkins, Rosenman and Zyzanski, 1974). However, the JAS is not as successful a predictor of CHD as the SI (Brand, Rosenman, Sholtz and Friedman, 1976). A student version of the JAS (Glass, 1977) was also constructed and contains high reliability properties (p = 0.69-0.91) (Yarnold, Mueser, Gran and Grimm, 1985).

Nonetheless, Dimsdale (1988) concludes that the results of investigations indicating very high and low correlations between Type A behaviour and CHD are equivocal. A possible explanation appears to be the label of Type A behaviour is too broad an area to assess with one instrument (Johnston, 1989). Smaller subcomponents may produce a stronger relationship between CHD and behaviour. Researchers investigating potential mechanisms of the relationship between CHD and behaviour have also divided Type A into its subcomponents.

## Type A and Physiological Reactivity

A recent meta-analysis (Harbin, 1989) regarding the relationship between the Type A Behaviour pattern and physiological responsivity has revealed overall greater reactivity to stress in Type A males as opposed to Type A females. Type A males were found to respond to cognitive and psychomotor stimulus situations with a significantly

higher heart rate and systolic and diastolic blood pressure than Type A females (Harbin, 1989). Morell (1989) questioned the sex differentiation between Type A behaviour and stress responsitivity and suggested it may be due to the limited amount of investigations utilising women.

Morell (1989) consequently compared the cardiovascular reactivity of 41 Type A and B females during low or high stress conditions in a competitive reaction time task. Results indicated that both heart rate and skin conductance measures were significantly higher for Type A students in high, as opposed to low, stress conditions. No Type A-Type B x stress interaction appeared which indicated that Type A and Type B women did not differ in their stress responsitivity. However, subcomponents of the Type A behaviour pattern may be more predictive of physiological responding than the overall behaviour pattern (Harbin, 1989).

Hostile Type A's have been suggested as one subcomponent of the Type A behaviour which may exhibit greater sympathetic reactivity to stress. Houston, Smith and Cates (1989) report subjects classified as Hostile Type A's respond with heightened cardiovascular reactivity to competition. Others however, (Sallis, Johnson, Trevorrow, Kaplan and Hovell, 1987) found results to the contrary. That is, no relations between hostility scores and blood pressure or heart rate reactivity were found for challenging tasks such as mental arithmetic, the cold pressor, or the Stroop color-word interference test.

In an attempt to clarify this lack of consistency, Öhman et al. (1989) divided a sample of hostile Type A's into an Irritable and Impatient subcomponent, and a Hard-driving and Competitive subcomponent, as measured by selected responses on the Jenkins Activity Survey (JAS). Öhman et al. (1989) found that the irritation and impatience dimension, was significantly related to task-induced changes in heart rate while performing a continuous perceptual motor task. The authors concluded that like Type A, hostility is a complex construct that needs to be broken down into its core components and further investigations are required to determine if the irritable and impatient factor provides such a component. Future studies need to determine if persons scoring high in the irritation and impatient subscale, reliably exhibit greater cardiovascular reactivity in response to stressors such as competitive motor performance.

## Stress and Motor Learning

Walker and Tarte (1963) found that enhanced arousal states facilitate motor learning. The authors proposed a theoretical framework to explain the underlying mechanism of this phenomenon, the consolidation theory of learning. Walker and Tarte (1963) suggest that the neural memory trace established by practise will be more "robust" under high arousal. Since this neural trace is essential for the production of a structural modification in the

nervous system (represented as long-term memory), the higher arousal during the practice period will produce greater long-term memory.

The action decrement notion of the theory posits that during the active period (acquisition phase) there is a degree of temporary inhibition caused by psychological stress. This negative bias against correct recall serves to protect the memory trace against disruption. Consequently, the facilitative effects of practicing a task under arousal may not appear until some time after the initial practise sessions. Additionally Walker (1958) adds "the action decrement persists for a limited time and then dissipates. Under many circumstances the dissipation of the action decrement is followed by an action increment which is learning or habit strength" (p.130).

A number of studies have shown support for the consolidation theory when stressors which increased arousal were found to enhance learning (Marteniuk and Wegner, 1970; Sage and Bennett, 1973). However, certain methodological problems have existed which need to be addressed before definitive statements can be made about the consolidation theory. Sage and Bennett (1973), in their review of related literature, noted several methodological problems, including whether the presence of a stressor actually increases arousal as opposed to not affecting arousal levels, the need for the stressor

to be related to the criterion task, and individual differences in the subject's baseline levels of anxiety and arousal may moderate the rate of skill acquisition, and whether arousal affects learning or performance. The more intense activity trace may also result in temporary inhibition against correct recall.

Martens (1971, cited in Sage and Bennett, 1973) has defined performance as "observable behaviour of relatively short duration" (p.153), whereas learning was considered to be a "rather permanent change in performance brought about through practice or experience" (p.153). Researchers have consistently demonstrated an inverted-U relationship between unidimensional measures of state anxiety and performance. Martens et al. (1983) and Landers and Boutcher (1986), have suggested that athletes perform best when anxiety and consequent arousal is moderate, but that their performance deteriorates when anxiety increases or decreases from its optimal level. However, an important area of study thus far neglected in past research, is the relationships between arousal, particularly in response to acute stress, and skill acquisition in terms of consolidation theory.

Several investigations have examined the effects of induced arousal on learning and performance on the pursuit rotor apparatus while controlling for the methodological limitations previously discussed (Cox, 1983; Sage and Bennett; 1973). Cox (1983) randomly

assigned 96 subjects to one of three induced arousal conditions (control, failure-feedback and electrical shock). Subjects were given 21, 20-second acquisition trials under induced arousal conditions, followed 24 or 48 hours later by nine trials in the absence of arousal. Results revealed that female subjects receiving failure feedback instructions recorded significantly lower performance scores relative to the control and shock conditions. No differences were noted between the groups during the last nine trials. The reductions in performance for the females were attributed to the undermining of their self-confidence, which in turn, resulted in a performance decrement. Self-confidence also may have negated the increments in learning a motor skill, previously attributed to induced arousal (Sage and Bennett, 1973).

The fact no differences existed in the performance scores 24 to 48 hours after initial learning was in contrast to the results found by Marteniuk and Wenger (1970). These authors found improvement in performance 24 hours after pursuit rotor learning which had been previously enhanced by simultaneous stress administration. It was concluded that performance under stress, facilitated some part of the acquisition process involved in learning the pursuit rotor but that this effect has some latent period. Additional research to

determine the long-term effects of arousal on learning and retention in females has not been addressed. This area was examined in the present study.

## Sex Differences in the Stress Response

Gender has recently been suggested as a moderating variable in physiological responses to stress (Hastrup and Light, 1984; Stoney, Davis and Mathews, 1987). Stoney et al. (1987) conducted a meta-analysis of all related English language studies concerned with differences between males and females on their physiological responses during behavioural stress. Their results indicated that females had significantly higher heart rates at rest and during cognitive challenge. In contrast, males had statistically higher systolic blood pressure at rest and during cognitive challenge. Females had larger urinary epinephrine responses during stress in contrast to males, but not at rest. Stoney et al. (1987) concluded that men show greater physiological responses during acute behavioural stress than do women.

Stoney et al. (1987) caution against generalising sex differences for physiological stress responses which are affected by reproductive hormones, e.g. resting heart rate and metabolic measures. The authors suggest to specify at which stage of the menstrual cycle female subjects fall during testing and direct inferences accordingly. Also it was suggested that baseline values

be adjusted when examining sex differences, body mass, or body fat. These latter two parameters are also related to resting cardiovascular measures and may influence stress responses (Gustafson and Kalkhoff, 1982; cited in Stoney et al., 1987). Controlling for these variables has revealed that men have greater change from baseline levels in blood pressure response to a range of stressors when compared to women (Mathews and Stoney, 1988; Stoney, Mathews, McDonald and Johnson, 1988).

A meta-analysis conducted by Crews and Landers (1987) concerning aerobic fitness and reactivity to psychosocial stressors indicated a paucity of studies comparing gender differences on the ability to cope with psychosocial stressors. When discriminating for gender differences, the authors found a greater effect size to stress responses after aerobic exercise in males (0.45) than females (0.22). Thus, the effect of aerobic exercise on psychosocial stress responses amounts to approximately one-half of a standard deviation above that of control group or baseline value for males but only one quarter of a standard deviation for females.

Gender may also influence psychological responses to stress. Participation in physical activity seems to have different meanings and connotations for women and men (Berger and Owen, 1983). The influence of gender on mood change has been reported by Wood (1977). Men who

participated in a 12 minute run significantly decreased their state anxiety, while women evinced no change. Mood change has repeatedly been shown to be independent of gender as measured by the Profile Mood States (POMS) (Berger and Owen, 1983, 1988). However, basic gender differences on several of the POMS subscales have been reported. In resting mood state, women have been found to be significantly less tense ($p < 0.03$) and less confused ($p < 0.003$) than men (Berger and Owen, 1983). Consequently, gender is an area that warrants further study concerning the effects of exercise on mood and its effect on physiological responses to stress.

**Exercise and the Stress Response**

Researchers agree that physical activity may be an effective mechanism for coping with both cognitive and physically-induced forms of stress. Dusek-Girdano (1979) contends that the alleviation of stress product build up by using activity to dissipate or use up the stress products is the primary function of physical activity as a therapeutic mechanism for dealing with stress. However physical activity may be a stressor itself because of the physiological responses that it may elicit.

The general responses of several stress hormones to exercise (a single bout of physical activity) include increases in catacholamines and growth hormone during

light aerobic activity (below 65% maximum oxygen uptake),
as well as cortisol at higher levels of activity (above
65% maximum oxygen uptake) (Kinderman, Schnafel, Schmitt,
Biron, Cassens and Weber, 1982).  Exercise, as well as
other stressors, may also elevate heart rate, blood
pressure and plasma levels of lactic acid (Fox and
Mathews, 1981).  The similarity of these physiological
changes with recognised somatic stress responses has been
shown (Pierce and Stone, 1986).

Primarily, three research designs have been utilised
in examining the effects of exercise on stress.  The
affect of a single exercise bout upon somatic and/or
cognitive measures has been one method that has been
utilised to investigate the relationship between exercise
and the stress response (Boutcher and Landers, 1988).
Other investigators (Holmes and Roth, 1985; van Doornen
and de Geus, 1989) have compared cognitive and somatic
acute stress responses of aerobically fit with less fit
subjects.  However these two designs have threatened
internal validity.  People who exercise to maintain
superior cardiovascular fitness may differ from inactive
people in several respects other than their fitness
level. For example, they may contrast in psychological
traits that modulate stress sensitivity.  If this is the
case, any modifications in stress responsivity between
people at extreme ends of the cardiovascular fitness
spectrum cannot reliably be attributed to the disparity
in fitness between the groups.  To overcome this

methodological problem, a third approach has been to compare the acute stress responses of subjects prior to, and at the conclusion of, exercise programs.

The following review of the relationship between exercise and stress has been divided into three major headings: (1) somatic responses, (2) mental well-being, and (3) motor learning. The first section has been examined in respect to the three research designs that have been utilised in examining the effects of exercise on somatic stress responses. The second section assesses the influences of exercise upon mental well-being by summarising the effects of activity upon personality, behaviour, mood state and acute stress responses. The latter section has been reviewed with respect to the limited information available as to the influences of exercise upon learning and performing motor tasks.

## Exercise and Somatic Responses

Variability in exercise intensity and duration have been utilised in examining the effects of a single bout of exercise upon a wide range of somatic stress measures. De Vries (1981) found exercising at a heart rate (HR) of approximately 100 beats per minute lowered electromyographic (EMG) recordings by greater than 20% up to 90 minutes after exercise. A HR of 120 beats per minute only approached significant reductions (de Vries, 1981). In contrast, Bulbulian and Darabos (1986) found

greater reductions in spinal reflex activation in higher intensity exercise (21.5% reduction) than low intensity exercise (12.8% reduction). Electroencephalographic (EEG) tracings after aerobic activity (80-85% age-related maximal exercise heart rate for 20 minutes) have recorded significantly greater time in alpha in subjects with and without previous running experience (Boutcher and Landers, 1988). These emissions have been found to begin 20 minutes into a 30 minute aerobic exercise protocol (Fernhall and Daniels, 1984) and have been implicated in the apparent psychological benefits of aerobic exercise (Werse, Singh and Yeudall, 1983).

Collectively, this research suggests that a single bout of aerobic activity can result in significant somatic stress reductions. DeVries (1981) prescribes rhythmic exercise such as walking, jogging, cycling from five to 30 minutes at 30% to 60% of maximum intensities to be most effective at relieving somatic tension and continues that it is possible that very high levels of exercise may be counter productive. Extending the duration of this protocol to include a training program over several weeks, many authors have compared the stress responses of aerobically trained subjects to untrained.

Physiological adaptations occurring as a result of training are quite clear. Various responses elicited by exercise tend to decrease at submaximal workloads after sufficient training in repeated exercise sessions (Fox

and Mathews, 1981). Compared to untrained subjects, aerobically trained persons have lower heart rates and blood pressure, lactic acid (Fox and Mathews, 1981), as well as diminished plasma levels of cortisol and catecholamines during submaximal exercise (Astrand and Rodahl, 1986).

Similar neurogenic and endocrine response systems are involved in both the physiological responses to exercise as well as the somatic responses to psychological stress (Pierce and Stone, 1986). Consequently, Holmes and Roth (1985) predicted that the sympathetic responses of cardiovascular fit persons to psychological stress would be reduced as compared to the aerobically unfit. Van Doornen and de Geus (1989) warn, however, that there are essential differences between the physiological responses to stress and exercise. These authors hypothesised that physiological reactions to mental stress are somewhat "metabolically inappropriate". That is, during exercise, changes in cardiac output vary directly with workload and oxygen consumption, whereas during psychological stress cardiac output can increase greater than oxygen consumption would predict.

Relatively few studies have been conducted to examine directly the effects of aerobic exercise on physiological reactivity during psychological stress. Heart rate (HR) responses during psychological stress are attenuated in aerobically fit individuals (Cantor,

Zillman and Day, 1978; Holmes and McGilley, 1987; Holmes and Roth, 1985, 1988; van Doornen and de Geus, 1989). Other studies have shown negative results regarding differences in HR reactivity, however, HR recovery from stress tended to occur more rapidly in the aerobically fit (Cox, Evans and Jamieson, 1979; Plante and Karpowitz, 1987; Sinyor, Schwartz, Peronnet, Brisson and Seraganian, 1983; Sinyor et al., 1986). Systolic blood pressure responses during stress, in addition to HR, are less pronounced in college students categorized as high in aerobic fitness, relative to low aerobically fit students (Light, et al., 1987). Increases in diastolic blood pressure during stress are attenuated in association with physical fitness, in two studies which otherwise reported negative findings (Hull et al., 1984; Sherwood et al., 1989).

The meta-analysis by Crews and Landers (1987) concerning the effect of aerobic fitness on reactivity to psychosocial stressors indicated the average effect size on all dependent variables (somatic and cognitive) was significantly different from zero. That is, aerobically fit subjects had a reduced psychosocial stress response compared to either control group or baseline values. However, some authors have questioned the validity of meta-analyses because results are calculated from studies using a variety of methodological designs (eg. crossectional vs longitudinal). As such, it is debatable whether research of poor methodological design should not

be included in the meta-analysis or should receive less weighting as studies with more appropriate designs (Crews and Landers, 1987). Thus, the inconsistency of findings when comparing the stress responses of people with varying degrees of cardiovascular fitness needs to be addressed.

Van Doornen and de Geus (1989) have proposed that measuring only heart rate and blood pressure responses to psychological stress was inadequate for the complexity of cardiovascular responses to aerobic exercise and stress. Subsequently, the most comprehensive analysis of the cardiovascular stress response to mental stress as a function of cardiovascular fitness was undertaken. In addition to recording HR and blood pressure responses, van Doornen and de Geus (1989) measured stroke volume, total peripheral resistance and pre-ejection period as the index of cardiac sympathetic effects. Results indicated the pre-ejection period and heart rate response were smaller in the high fit group whereas vascular activity as recorded by total peripheral resistance and diastolic blood pressure was also greater than baseline in the low fit group.

The van Doornen and de Geus (1989) investigation displayed a clear difference between the stress response of fit and less fit persons and may have eventuated as a result of comparing extreme groups in cardiovascular fitness. In fact an improvement of over 35 percent in

estimated maximal oxygen uptake would have been required by the low fit group to equal the fitness of the high fit group. The Holmes and Roth (1985) investigation, which also recorded significant differences in stress responses would have required low fit subjects to increase their cardiovascular fitness even further. Assessment of cardiovascular fitness represents another limitation in the related literature that may account for some of the conflicting research outcomes.

Cardiovascular fitness has been assessed in the aerobic fitness-stress response literature utilising a variety of methods. Estimates such as self report measures of physical activity (Light et al., 1987; Plante and Karpowitz, 1987), maximal walk/run distance (Holmes and McGilley, 1987; Moses et al., 1989) and endurance time (Hull et al., 1984) have been extensively criticised and not recommended for research purposes when more accurate methods are available (Astrand and Rodahl, 1986). Other investigations (Holmes and Roth, 1985; Sinyor et al., 1986) have assessed cardiovascular fitness utilising estimated maximal oxygen consumptions ($VO_2$ max) from heart rate obtained during a submaximal exercise assessment. The heart rates have then been extrapolated utilising the nomogram of Astrand (Sinyor et al., 1983).

The validity of the Astrand nomogram (Astrand, 1960) has been questioned by Astrand and Rodahl (1986). The nomogram has been noted to have a standard error of up to

15 percent in moderately trained individuals and produce a trend that implies increases in error with decreases in fitness (Astrand and Rodahl, 1986). The reported correlations between maximal oxygen uptake and walk/run tests have also ranged from 0.04 to 0.90 (Shepard, 1982; cited in Astrand and Rodahl, 1986). These measurement inadequacies may explain why some investigations did not establish significant differences in the cardiovascular responses to stress in subjects of varying fitness levels.

A further methodological inconsistency, which may partly account for the discrepancies in research comparing cardiovascular stress responses in persons of various aerobic fitness levels, is the use of cross-sectional versus longitudinal designs. As previously noted, people who exercise in an attempt to maintain superior levels of cardiovascular fitness may differ from inactive people in several respects other than their fitness level. Such differences may in turn affect stress responsivity. Of the investigations discussed which recorded significant differences in cardiovascular stress responsivity between aerobically fit and unfit individuals, only Holmes and McGilley 1987; Holmes and Roth (1988) Sinyor et al., (1986) and Sherwood et al., (1989) utilised longitudinal designs. Consequently, only heart rate (Holmes and McGilley, 1987; Holmes and Roth, 1988) and diastolic blood pressure responses to stress, and heart rate recovery (Sinyor et al., 1986), have been

found to be reduced in subjects who improve their cardiovascular fitness after 10 and 12 weeks of aerobic fitness training, respectively. Methodological inconsistencies are also evident within research examining the effects of exercise programs upon cognitive stress response variables.

## Exercise and Mental Well-Being

Many of the early investigations relating physical activity and fitness with improved mental well-being, in normal populations, were correlational or cross-sectional in nature, with non-random assignment of subjects (Folkins and Sime, 1981; Hughes, 1984). Data from randomised trials comparing exercise with no treatment have been less consistent across a number of cognitive and behavioural variables. The effects of exercise training have been investigated in relation to personality variables, behaviour, and mood states.

Research relating physical fitness to personality variables initially found no reliable results due to its preoccupation with comparisons of athletes and non-athletes (Folkins and Simme, 1981). Folkins and Simme (1981) concluded that there was no evidence to support a claim that global changes on personality tests follow from fitness training. However, self concept appears to be the personality variable most likely to change after an exercise program.

Self-concept is usually improved with exercise and has been strongly correlated with exercise in most studies (Hughes, 1984). Using a 10 week exercise program which was found to significantly increase cardiovascular fitness, Hilyer and Mitchell (1979) found positive changes in both male and female college student self perceptions. These increases have been found to be greatest for subjects who were initially in the lowest cardiovascular fitness category (Eickhoff, Thorland and Ansorge, 1983). Similar increases have been recorded using strength training without significant cardiovascular developments (Tucker, 1983a).

Changes in self concept maybe associated with the perception of improved fitness rather than with actual changes in physical fitness. Heaps (1978) for example, found that male subject's perception of their fitness level was enhanced with the use of positive (self enhancing) social or physical information. Consequently, self concept appears to be affected by exercise training participation. Data assessing the effects of exercise upon behaviour have been less conclusive.

## Type A Behaviour and Stress Intervention

Initially, investigators have examined the effects of exercise upon the Type A behaviour pattern. Blumenthal, Sanders, Redford, Williams and Wallace (1980) demonstrated Type A behaviour could be significantly

modified by a 10-week exercise program. One proposed mechanism for these changes was that Type A individuals may derive a particular sense of benefit from the mastery and self-control afforded by an exercise program (Blumenthal et al., 1980). Type A score reductions from participation in exercise programs are far from conclusive.

Roskies et al. (1986) randomly assigned Type A men to one of three treatments: cognitive behavioural stress management, jogging, and the control activity of weight training. Subjects who practised in cognitive behavioural stress management techniques for 10 weeks significantly reduced their Type A behaviour pattern, as measured in a structured interview. Those in the jogging and weight training treatments did not. Other investigations have also failed to record any changes in Type A scores from moderate aerobic exercise or intensive aerobic activity (Moses et al., 1989). A potential explanation for the lack of consistency in these results maybe the inefficient quantification of Type A scores.

Recently, Type A behaviour has been divided into subcomponents in an attempt to find a more reliable behavioural factor related to Coronary Heart Disease (Houston et al., 1989). Hostile Type A behaviour has been divided into an Irritable and Impatient subcomponent and a Hard driving and Competitive subcomponent (Öhman et al., 1989). Initial results indicate that subjects

scoring high in Impatience react with greater cardiovascular reactivity to mental stress. As yet, no investigations have attempted to assess the effects of any stress management techniques, including exercise, on reducing Irritable and Impatient subcomponent scores. In contrast, a great deal of literature has attempted to assess the influences of exercise upon mood state.

The effects of single bouts of exercise upon mood state are regularly addressed in the related literature. Casual implications permissible from these investigations are limited by potential individual differences in the exercising subjects such as test taking attitude and aerobic fitness (Blumenthal, Williams, Needles and Wallace, 1982; Steptoe and Cox, 1988). Nonetheless, investigations continue to demonstrate that single bouts of vigorous aerobic exercise reduce state anxiety (Boutcher and Landers, 1988). Forty minutes of self-paced exercise, as opposed to quiet rest, has resulted in these reductions remaining for up to three hours post treatment (Raglin and Morgan, 1985). Morgan's (1985) study showed that most individuals report they "feel good" or "feel better" following vigorous aerobic exercise.

Steptoe and Bolton (1988) have recently compared the short-term stress relief provided by single bouts of low intensity versus high intensity exercise. The Profile of Mood States was administered to 20 female subjects in

each of two exercise conditions, before, during and immediately after exercise and over a 15-minute recovery period. Results revealed that tension and fatigue significantly increased immediately after high intensity exercise, declining over the recovery period. During exercise however, anxiety diminished in the low but not the high intensity condition. High fit subjects reported greater feelings of vigour than moderately fit subjects following high intensity exercise. Feelings of vigour have previously been recorded in all subjects immediately after participation in eight-minutes of low intensity exercise (Steptoe and Cox, 1988). Consequently, for low fit subjects single bouts of low intensity exercise appears to promote positive short term mood changes whereas high intensity exercise causes short term stress increases. Persons with superior levels of aerobic fitness do not appear to be as negatively affected by high intensity exercise as low fit individuals. Due to internal validity limitations of research comparing the effects of a single bout of exercise upon mood, several studies have been designed to assess the effects of extended exercise training upon mood state.

Blumenthal et al. (1982) matched sixteen male and female adult fitness participants with sixteen controls for age, education, sex and health status. Exercisers then participated in a 10 week aerobic conditioning program which significantly increased cardiovascular fitness. Short-term stress reduction as measured on the

Profile of Mood States, was recorded by the exercisers who exhibited significantly less tension, depression and fatigue, and more vigor than the controls directly after exercise at the conclusion of the ten weeks. These results have been duplicated in college students participating in swimming classes, with decreases in anger and confusion recorded as well (Berger and Owen, 1983). No long-term stress reductions were recorded in either study. The results of Blumenthal et al. (1982) and Berger and Owen (1983), however, were limited by their use of exercisers who sought out exposure to training as opposed to randomly assigning subjects to the treatment conditions.

Goldwater and Collis (1985) attempted to eliminate these contaminations by randomly assigning 51 college students to either a six week cardiovascular conditioning treatment or a control group which was designed to give the appearance of physical training while minimizing cardiovascular benefits. Both groups significantly improved cardiovascular fitness, although the cardiovascular group improved significantly more so. On selected components of the Minnesota Multiphasic Personality Inventory (M.M.P.I.), the experimental subjects showed a greater decrease in anxiety and a greater improvement in self-reports of psychological well being. Unfortunately, there were more supervised classes in the exercise condition, so differences in the amount of attention given to the groups may have been present.

A further limitation of the literature relating physical activity with psychological change is that most of the early literature did not document fitness effects and, as such, were more often appropriately identified as sports participation studies (Folkins and Sime, 1981). More recently, investigations that have recorded cardiovascular fitness have also typically utilised assessment techniques with lower levels of reliability, such as the Harvard Step Test (Goldwater and Collis, 1985). As previously discussed, there is debate as to whether the psychological changes accompanying physical activity are due to the activity or the aerobic conditioning component of the activity.

Moses et al. (1989) attempted to clarify the anomalies between exercise participation and the development of cardiovascular fitness by randomly assigning 109 sedentary adult volunteers to one of four conditions: high intensity aerobic training, moderate intensity aerobic training, weight training placebo and waiting list. Training was implemented over a 10 week period and significant increases in cardiovascular fitness were observed in the three active conditions. Long-term stress reduction was manifest at the conclusion of training on measures of tension and confusion and at 3 month follow-up on measures of perceived coping ability. The long-term stress reductions were observed in the moderate exercise condition but not in the high exercise or weight/flexibility placebo conditions. Improved mood

profile has also been recorded at three month follow-up after a 12 week jogging and aerobic dance program. Both activities significantly increased cardiovascular fitness (Simons and Birkimer, 1988). These later results support Moses et al.'s (1989) contentions that psychological responses to exercise training are not due to expectancy or other features inherent in structured activity, but only emerge when an aerobic component is also present.

Tentative support for the mood benefits associated with moderate, as opposed to high or low intensity forms of exercise has been reported by Gondola and Tuckman (1983). These authors found more positive resting mood state profiles in joggers who ran 25 miles/week than exercisers who ran 50 miles/week or 10 miles/week. Berger and Owen (1988), in their attempt to construct a taxonomy of exercise to induce short-term and long-term stress reduction, determined that as well as containing an aerobic component, the activity needs to also be repetitive, predictable and in a non-competitive environment.

The effects of moderate non-competitive aerobic exercise and consequent cardiovascular development upon cognitive acute stress responses has received only scant attention in the literature. Several investigations have examined psychological responses to acute stress as an adjunct to physiological responses in persons of differing cardiovascular fitness (Cantor et al., 1978;

Holmes and Roth, 1985; Holmes and McGilley, 1987, Sinyor et al., 1983; Sinyor et al., 1986). In one of these investigations, differences in anxiety were not found between low and high cardiovascular fit subjects during stress, but following a 15 minute recovery period the low fit subjects reported higher levels of state anxiety (Sinyor et al., 1983). Of the five training design investigations the remaining four investigations there was no significant differences between high and low fit subjects in their subjective reports of cognitive and somatic acute stress responses (Cantor et al., 1978; Holmes and Roth, 1985; Holmes and McGilley, 1987; Sinyor et al., 1986). However, of these four investigations, two utilised the less conclusive correlational design (Cantor et al., 1978; Holmes and Roth, 1985). Also, Holmes and McGilley (1987) attempted to stress subjects with a three minute number reversal series, which may not have been intense or long enough to produce differences in stress responses.

Finally, Roth et al. (1989) have examined the effects of exposure to an acute stressor while participating in moderate aerobic exercise. These authors found the short term stress reductions recorded after exercise, were attenuated, by administering an acute cognitive stressor while exercising. No investigations appear to have measured the effects of acute stress on the long-term stress reductions also recorded after exercise. The effect of exercise training upon motor learning has also received minimal attention.

## Exercise and Motor Learning

Acute stressors which subject individuals to conditions of high stimulus overload or high task demand can result in subsequent improvement in learning (consolidation theory) (Walker and Tarte, 1963). Such enhanced learning has been recorded particularly in tasks which include a substantial physical/motoric component (Marteniuk and Wenger, 1970; Sage and Bennett, 1973). Several factors which have been found to lead to decrements in skill acquisition have been the presence of an audience in combination with a mirror (Innes and Young, 1975) evaluation apprehension (Geen, 1980) and the use of negative feedback to induce arousal in female subjects (Cox, 1983).

To date, studies comparing the psychological stress reactivity of discrete cardiovascular fitness groups have focused on self-report, neuroendocrine, or physiological responses. Superior cardiovascular fitness has been noted to reduce somatic responses and thus induced arousal in response to acute stress (Holmes and Roth, 1985; van Doornen and de Geus, 1989). If stress induced arousal levels are, in fact, reduced in persons with superior cardiovascular fitness, would there be a cardiovascular fitness level influence on motor learning in response to an acute mental stressor? Research is virtually nonexistent in this area. However, motor performance in response to an acute mental stressor has

been found not to differ in subjects varying in cardiovascular fitness level (Sothmann, Horn, Hart and Gustafson, 1987).

Sothmann et al. (1987) recorded that subjects classified as high-fit and low-fit were similar in psychomotor performance as reflected by total reaction time during a vigilance task. This finding with reaction time is consistent with another similar investigation (van Doornen and de Geus, 1989). Both the Sothmann et al. (1987) and van Doornen and de Geus (1989) investigations utilised correlational methodologies to contrast persons with extreme differences in cardiovascular fitness and standard threats to internal validity exist (Folkins and Sime, 1981). Further as the investigations assessed performance only, limited implications can be extrapolated for the potential relationship between cardiovascular fitness and motor learning. There remains a need to assess whether any motor learning changes eventuate in subjects who participate in an exercise training program.

## Stress Management Interventions

The origins of relaxation techniques used in stress management are to be found in the traditions of the East, where meditation has been practised for thousands of years, but such techniques have generally not been subjected to Western experimental scrutiny. It is

primarily Western adaptations such as progressive muscle relaxation (Jacobson, 1936) and Benson's Relaxation Response (Benson, 1975) that have received such evaluation. In Buddhism the practice of meditation goes back about 2,500 years to the time of Gotama the Buddha in India, where he taught how to read the path to spiritual enlightenment. During the night when he achieved enlightenment he is reported to have used a practice of breathing in and out quietly concentrating on the flow of breath at the tip of the nostril, counting a small number of breaths and repeating the counting. This has become known as "anapanasati", a "samatha" practice of meditation, designed to calm the mind and develop concentration (Sheppard, 1989). The other major practise in Buddhist meditation is Vispassana meditation, designed for the development of insight (Benson, 1975).

About 2,000 years ago, Sankhya philosophy was founded by Kapila in India, and from these teachings Patanjali developed Raja Yoga in 200B.C. From this source Transcendental Meditation (TM) has been developed in the 20th Century by the Maharishi Mahesh Yogi, and many styles of yoga have appeared (Sheppard, 1989). Satyanda Yoga, with its practice of yoga nidra, the systematic rotation of awareness in the body, represents one such style.

Yoga Nidra is a systematic method of inducing complete physical, mental and emotional relaxation (Saraswati, 1984). Satyanda Yoga comprises of yoga nidra, in accompaniment with practises of postures, stretching and volume regulation of respiration. The Yogic style represents one of the more active forms of yoga. The following review will initially discuss literature generalizing the physiological responses attested to several meditative techniques and will then summarise the literature relating specifically to the somatic effects of yoga. The cognitive effects of yoga will then be discussed and a concluding section will review comparative studies of active and passive stress management techniques.

## Somatic Effects of Yoga

Wallace and Benson (1972) in their comprehensive analysis of the physiology of meditation found significant attenuation of oxygen consumption, carbon dioxide elimination, heart rate, blood lactate and more frequent alpha brain wave emissions in meditators during the practice of transcendental meditation. Benson (1975) proceeded to document similar hypoarousal responses in a range of stress management techniques such as progressive muscle relaxation and autogenic training and labelled the physiological state induced by these procedures as the relaxation response. The effects of Yoga Nidra practice have also been linked with elicitation of the relaxation response (Saraswati, 1984).

The relaxation response is a self-induced altered state of consciousness (Benson, 1975). The elicitation of the relaxation response results in physiological changes thought to characterize an integrated hypothalmic function (Wallace and Benson, 1972). These changes are consistent with generalized decreased sympathetic nervous system activity. As such, it is suggested (Benson, 1975) that the relaxation response is the inverse counterpart of the hyperarousal reaction to acute stress and has implications for use as an "antidote" for stress reactions (Goleman and Schwartz, 1976).

Elevated resting blood pressure has been noted as a physiological response to long-term stress (Johnston, 1989). Patel and North (1975) assessed the effects of yoga combined with biofeedback in an attempt to reduce the resting blood pressure of hypertensive subjects. Subjects matched for sex and age were randomly allocated to treatment and control groups. Results revealed a significant reduction in systolic (26mmHg) and diastolic blood pressure (15mmHg) in the treatment group compared to the controls.

In a comparative study, Bagga and Gandhi (1983) evaluated the effect of Transcendental Meditation and Yoga Meditation with a control condition on novice subjects after six and twelve weeks of practise. Heart rate and blood pressure records were significantly lower, prior, during and after the meditation session at six and

twelve weeks for both treatment groups. The fall in diastolic blood pressure was not as great for the Yoga-meditation group as the transcendental meditation treatment, however both scored significantly lower blood pressure than the controls.

Patel (1975b) compared the cold pressor test responses in subjects who had been practising yoga in combination with biofeedback and a control group. Results indicated that experimental group subjects recovered more quickly from their stress responses than did control subjects. Patel (1975b) proposed no mechanisms for such acute stress recovery attenuation in subjects practising yoga.

Although Shannahoff-Khalsa (1984) did not specifically mention yoga, he did report that airflow into the right and left nostrils is tightly coupled with the normal hourly fluctuations in dominance of right and left cerebral hemispheres. Alternate nostril breathing is a common activity of yoga (Morse, Cohen, Furst and Martin, 1984; Saraswati, 1984). Respiratory rate has also been found to pre-empt other autonomic responses such as heart rate and skin resistance levels (Morse et al., 1984). These respiratory autonomic nervous system relationships have been concluded to support the yoga contention that respiration initiates autonomic nervous

system responses. Decreased respiratory rate is a recognised response in subjects practising yoga nidra (Saraswati, 1984).

Of note, Holmes (1984) in a review investigating the influences of meditation upon somatic arousal concluded not one measure across experiments revealed reliably lower arousal in meditatory subjects than resting controls. He also found only two studies which revealed reliably lower arousal for meditatory subjects than "resting" controls on more than one measure. Finally, Holmes (1984) noted that in stressful situations, no investigation had found meditating subjects to display lower somatic responses to acute stress. Although not reviewing the Satyanda Yoga technique perse, Holme's (1984) assessment of meditation may have implications for the effectiveness of yoga nidra.

In response both Shapiro (1985) and Benson and Friedman (1985) criticised the Holmes (1984) review as self selecting and also failing to consider that there is no evidence of somatic arousal reductions from meditation greater than any other relaxation technique. Holmes (1984) was criticised for his acceptance of "simple rest" as a placebo when in many studies this was infact a relaxation technique (Benson and Friedman, 1985). These authors continued that when an investigation incorporated a rest condition which did not elicitate a relaxation response, there were significant differences between

quiet rest and relaxation. However, the Holmes (1984) review did highlight the lack of a distinction between the physical changes of meditation and other relaxation techniques (Benson, 1975). Rather, it appears the various relaxation techniques differ in the subjective psychological experience they elicit (Borgeat, Stravynski and Chaloult, 1983).

## Cognitive Effects of Yoga

Yogic breathing, as well as initiating autonomic nervous system changes (Morse et al., 1984), appears to be related to the psychological affect. Harvey (1983) compared the mood effects of a four week class of yogic breathing exercises, a six week class on the philosophy of meditation, and a 12 week course in psychology. Decreases in short term stress levels were reported in subjects participating in the breathing classes only. Specifically, results of Profile of Mood State questionnaires, revealed the breathing class group felt significantly more vigor and less tension, fatigue and depression, relative to subjects in the control groups. These results confirm speculation that mood may be changed by altering the phase of the nasal cycle (Berger and Owen, 1988). Most relaxation techniques incorporate some form of breathing modification into the stress management procedure. As a result, breathing modification may have similar affects across all stress management techniques.

Although a range of relaxation procedures appear to cause similar hypoarousal responses (Benson, 1975), some disparity exists as to whether the subjective experience of the various stress management techniques are subjectively interchangeable. Borgeat et al. (1983) for example, found the subjective responses of subjects participating in autogenic training and progressive relaxation were different and unaffected by investigator influences and suggestions concerning the expected effects. In particular, a greater emergence of mental images and emotions was recorded by the subjects participating in autogenic training.

Kalayil (1988) compared the effects of yoga meditation, progressive relaxation training, catnap and the control group magazine reading, in reducing state anxiety as well as determining the subjects' perceptions regarding the effectiveness of the training experience for relieving headaches, insomnia and general tension. The sample consisted of 80 middle grade students who were randomly assigned to the four conditions. Results indicated the progressive relaxation training and yoga meditation techniques proved to be more effective in reducing state anxiety and headaches and general tension than either the magazine reading of catnap strategies. Consequently, yoga meditation and progressive muscle relaxation did not differ in the cognitive stress relief they provided. The similarities between these two techniques are indicative of the similarity in results.

Great discrepancies occur when comparing yoga, a passive stress management technique, to exercise, an active stress relaxation procedure.

## Active versus Passive Stress Management Techniques

Both exercise and yoga meditation represent stress reduction techniques (Berger and Owen, 1988). From the proceeding review, it was clear that the effects of aerobic exercise (Berger and Owen, 1983, 1988; Morgan, 1987) and to a lesser extent yoga meditation (Harvey, 1983; Patel, 1975b) upon somatic and cognitive stress responses have been investigated in comparison with control groups. Few experimental studies have compared aerobic activity (active) with cognitive relaxation (passive) stress reduction techniques. The few comparative investigations available have been plagued by a variety of methodological problems, as reviewed by Silva and Schultz (1984). Typical problems have included a striking absence of control groups (Greist, Klein, Eischens, Faris, Gurman and Morgan, 1979) and utilisation of cross-sectional rather than longitudinal methodologies (Schwartz et al., 1978). The following review initially summarises the investigations that have compared the changes in cognitive stress responses between active and passive stress management techniques. The only investigation that has compared the somatic acute stress

responses of active (aerobic exercise) with passive (progressive muscle relaxation) stress management programs, concludes the summary.

In one of the earliest comparisons of stress reduction techniques that included exercise, Bahrke and Morgan (1978) assessed the effects of exercise, meditation and distraction on the anxiety levels (state and trait) of 75 adult males. The subjects were randomly assigned to one of the three groups with each treatment enduring for a period of 20 minutes. The results showed that all three groups experienced significant reductions in state anxiety and the authors concluded that exercise, meditation and distraction seemed to possess comparable anti-anxiety properties. More recently, however, state anxiety decrements following exercise have been found to persist for a longer period of time than those observed following distraction (Raglin and Morgan, 1985). Direct cause and effect conclusions cannot be derived from this single treatment design as the groups may have differed in personality factors or some other moderating variables.

Long (1984) assigned male and female subjects to 10 weeks of aerobic conditioning or stress inoculation. Both conditions were found to decrease self-reported tension as measured by a tension thermometer and improve subject self-efficacy as opposed to waiting list controls. Pre-treatment differences in aerobic fitness

between groups limit permissible interpretations from this study. A further comparison of exercise training with relaxation and no treatment has been reported by Roth and Holmes (1987). Subjects in this study were selected on the basis of high levels of recent negative events. Physical and psychological health were assessed with self-report measures before, halfway through, immediately following, and eight weeks after an 11-week training (and control) period. Midway through training aerobic exercise was associated with greater reductions in depression than the other conditions, but there were no differences in measures of anxiety or physical symptoms.

In an attempt to determine an Exercise Taxonomy for stress reduction, Berger and Owen (1988) used the Profile of Mood States to compare the short-term and long-term stress reduction benefits of four activities; swimming, Hatha yoga, body conditioning and fencing. A total of 170 college students self selected their activity of choice and participated in an approximate 12 week exercise program. Exercise characteristics considered necessary for stress reduction included an aerobic quality, an absence of competition, predictability and rhythmical movements. By far the greatest relative short-term stress reductions were recorded in the Hatha yoga group who were less anxious, tense, depressed, angry and confused after exercising than before. Hatha yoga was considered to satisfy the last three necessities for

stress reduction, without an aerobic component. However selected yogic exercises have recently been found to also increase physical fitness (Kanade, 1990). Nonetheless, subject self selection represented a limitation of the study.

To clarify these results, Berger et al. (1988) compared the short-term and long-term stress reductic benefits of three stress management activities; Benson' Relaxation Response (Benson, 1975), jogging and grou interaction to those of a lecture-control group. A tot of 387 college students were randomly assigned to one c the four treatments for a 12 week period. Result revealed both the jogging and the Benson's Relaxatic Response group significantly decreased in tensior depression, and anger to record short term reductions i stress. Positive long-term alterations in mood profil were noted for the exercise and control groups Consequently, these long-term stress reductions could nc be solely attributed to exercise.

Finally, only one investigation has compared the effects of aerobic training relative to the effects of a passive intervention, progressive muscle relaxation, upon somatic acute stress responses. Holmes and Roth (1988) randomly assigned students who reported experiencing a high number of stressful life events to an aerobic training condition, a progressive relaxation training condition and a no treatment control condition. After an

11 week training/control period only subjects in the aerobic training condition reduced their heart rate responses to stress and in recovery from stress.

In contrast to progressive muscle relaxation, yoga has been found to reduce resting levels of heart rate (Kalayil, 1988) and blood pressure (Patel, 1975a). At present, no information is available as to whether aerobic training is more or less effective than yoga at reducing somatic acute stress responses.

In conclusion it appears both exercise (active) and yoga (passive) utilised as stress reduction techniques may precipitate alterations in cognitive responses to acute stress. No information is available regarding the comparative effectiveness of the two techniques at reducing somatic acute stress responses. Furthermore, combination strategies have been suggested to induce greater stress relief than either active or passive stress management (Bruning and Frew, 1987). Rosenbluh (1985) postulates that stress management should incorporate vigorous exercise, relaxation and proper nutrition to combat stressors and reduce health risks. For the purposes of experimental vigour however, the two stress management techniques need to initially be assessed separately.

## Summary

It is evident from the reviewed literature that stress is a multi-dimensional experience with psychological, behavioural and physiological components. Any one or combination of these components, may affect performance. Consequently, the management of stress should be assessed in terms of cognitive, behavioural and physiological perspectives. Any of these components may affect the learning and performing of motor skills.

The psychological effects of stress management programs have resulted in the short-term and long-term stress reduction of stress in response to moderate aerobic exercise (Berger et al. 1988; Moses et al., 1989) and yoga (Berger and Owen, 1988; Harvey, 1983). Investigators have found, however, the administration of an acute stressor during an exercise bout appears to decrease the short term stress reductions directly after exercise (Roth et al., 1989). Further research needs to help determine whether long-term stress reductions that may eventuate from a stress management program act as a buffer against the administration of an acute stressor. That is, there is a need to assess whether reduced long-term cognitive stress attenuates the consequences of an acute mental stressor upon short-term stress levels.

The behavioural influences of stress have primarily been addressed via the measurement of the Type A coronary prone behaviour pattern. The characteristics of Type A behaviour include competitiveness, aggression, anger, irritability, and impatience (Herbertt, 1988). Recently, the relationship between the Type A behaviour pattern and CHD has been questioned. Subcomponents of Type A have been constructed which may be more predictive of the relationship between behaviour, stress reactivity and disease. For instance, the Irritable and Impatient subcomponent positively related cardiovascular reactivity to mental stress (Öhman et al., 1989).

The somatic influences of stress management programs have recently examined the effects of cardiovascular fitness upon stress reactivity. Several descriptive investigations have linked higher levels of aerobic fitness to reduced cardiovascular responses to acute psychological stress. However, relatively few longitudinal investigations have been reported in which aerobic fitness training programs were shown to be more effective than no treatment for reducing the cardiovascular response to stress. Furthermore, the investigations concerning the effect of cardiovascular fitness upon the stress response have failed to compare active (aerobic exercise) and passive (yoga) stress management techniques which have both been found to decrease resting heart rate and blood pressure measures.

At present, information is lacking regarding the effect of aerobic training as opposed to yoga on a person's physiological response to stress.

Finally, the influences of stress upon cognitions, and motor performance need further investigation. Increased arousal, induced by acute mental stressors, has been found to increase learning on the pursuit rotor apparatus (Marteniuk and Wenger, 1970; Sage and Bennett, 1973). These findings are consistent with the Consolidation Theory of skill acquisition (Walker and Tarte, 1963). The influences of increased cardiovascular fitness upon lowering arousal responses to acute stress may, in turn, effect the consequent arousal-learning relationship. That is, superior levels of cardiovascular fitness may actually decrease the learning of a motor skill, at least one that requires a relatively high arousal state, under acute stress conditions. This may occur by inducing an under-arousal state in response to the acute stressor. Further research is needed to assess the consequences of stress upon motoric, cognitive, behavioural and somatic acute stress responses.

## CHAPTER III

## METHODS AND PROCEDURES

### Subjects

Female, undergraduate University students from the University of Wollongong (N=44), between the ages of 18 and 24 years, served as volunteer subjects in the study. Subjects were recruited from classes throughout the University. All subjects met the criteria of low aerobic fitness with no formal stress management experience. The subjects were then randomly assigned to one of four conditions: (1) a group that engaged in a 10 week moderate aerobic exercise program; (2) a group that participated in a 10 week Satyanda Yoga program; (3) an art appreciation-placebo group which met for 10 weeks; and (4) a no stress control group which received no intervention.

### Instruments and Materials

#### Psychological Measures

**Mood.** The Profile of Mood States (POMS; McNair et al., 1971) was used to measure cognitive stress levels. The POMS has been widely employed in other studies of exercise and stress (Berger, Friedmann, Eaton, 1988; Berger and Owen, 1988; Moses et al., 1989; Morgan, 1980). The six POMS subscales include tension/anxiety,

depression/dejection, anger/ hostility, vigor/activity, fatigue/inertia and confusion/ bewilderment. The combined POMS score includes the sum of the six factors (weighting vigor negatively). Previous authors have employed the combined POMS (Total Mood Disturbance) score as a measure of Global Mood to help determine the necessity of individual subscale analyses (Raglin, Morgan and Luchsinger, 1990). Test-retest reliability coefficients for the subscales range from 0.65 to 0.74 (McNair et al., 1971). The "right now" response set was employed in this study as used in past studies (Berger and Owen, 1988; Moses et al., 1989). To encourage honesty, objectivity, and anonymity in completing the assessment, all responses remained confidential.

Competitiveness. As the acute cognitive stressor utilised in the present investigation was primarily competition with a confederate, individual differences in the subject's predisposition for competitiveness needed to be assessed.

The revised 25-item Competitiveness Inventory (Gill, 1986) was used to ascertain this measure. It consists of a sport-specific multidimensional measure of the person's desire to strive for and achieve success in physical activity situations. It has been successfully utilised in previous assessments of the competitive orientations of participants in physical activity classes (Gill, 1986). All inventory items were rated on a 5-point scale

ranging from strongly agree to strongly disagree. The Competitiveness Inventory yields competitiveness, win and goal orientation factors and reports internal consistencies in the range of .80 to .94.

**Type A behaviour**. To ascertain the extent the subjects displayed coronary prone behaviours, the Student Version of the Jenkins Activity Survey (JAS) (Glass, 1977) was used to assess Type A behaviour. It measures the Type A behavioural pattern of college students under the age of 25 years. The JAS consists of 44 multiple-choice questions, of which 21 are scored using a unit-weighting procedure to determine an overall Type A score and three related scales (speed and impatience, involvement, and hard-driving and competitive). Only the fully weighted Type A score has been shown to predict coronary heart disease (Jones, 1988). Test-retest reliability coefficients for the total JAS score ranged from 0.70 to 0.96 (Yarnold, Mueser, Grau and Grimm, 1986).

Type A and Type B are often assigned in research on the basis of a median split. As this may confuse the treatment of the Type X's in the middle, this research assigned subjects in the top and bottom thirds only as A and B, a technique that has been previously utilised (Jones, 1988).

## Physiological Measures

**Tri-level aerobic power index.** The primary purpose of the cardiovascular measure in the current investigation was to indicate fitness change. Initial aerobic fitness levels was determined by the Aerobic Power Index (API) (submaximal test) of the Tri-Level Profile of General Fitness (Telford, Minikin, Hooper, 1988). Test-retest reliability of the API is generally higher than other submaximal techniques which predict cardiovascular fitness (Telford, 1989). Initially, to determine the API score, the subject's mass was recorded in kilograms (.01). A sports tester (Model PE3000) was attached to the subject to provide instantaneous heart rate measures which were updated every five seconds. Electrolytic paste acted as a conducting medium between the body surface and the electrodes to further enhance recording quality. The display band was held by the experimenter who stood no further than one metre from the subject at any time.

**Heart rate.** Target heart rate (THR) was calculated by the formula; THR = 0.75 x (220 - Age). The Exertech Work Monitor (EX50) was connected to the Exertech Cycle Ergometer (EX10) and set on the "low" range. The subject began pedalling at a load of 25 watts which was increased by 25 watts at the conclusion of each minute. The test was stopped at the end of the minute during which THR was reached. The power (watts) at which THR was theoretically reached was calculated and then divided by

the subjects body weight, resulting in an aerobic index expressed as watts/kg. A correction factor which accounts for laboratory environmental variations in pressure and temperature, which in turn affect air and mechanical resistance from the utilised air braked ergometers needed to be calculated. The factor was determined by the formula

$$\text{Factor} \quad = \quad \frac{\text{Pressure}}{760} \quad x \quad \frac{295}{273+T}$$

(where P and T represent barometric pressure in mmHg and air temperature in degrees Celsius, respectively). The Correction Factor was then multiplied by the original watts/kg figure to give a final adjusted aerobic power index score. The assessment did not continue for longer than six minutes due to the low levels of cardiovascular fitness assessed and consequently provided adequate warmup to then examine subject flexibility.

**Flexibility**. A hamstring/lower back functional unit assessment of flexibility was then conducted with the use of a sit and reach apparatus. With shoes removed, subjects were seated on the floor with their feet against the measuring stool. Upon reaching forward with legs extended at the knee, the fingers were pushed along a scale and held for a three-second period in the end position. Three trials were administered, the longest distance reached by the subject was recorded to the nearest millimetre.

**Body fat**. Estimated body fat sum was assessed with a pair of Harpenden skin fold calipers (Model No. 356) to measure skinfold thickness from the biceps, triceps, subscapula, supra-iliac, abdominal, thigh and calf (Telford, Edgerton, Hahn and Panget, 1988). The average of three measures for each site were added and the sum regarded as the subject's body fat total (Telford et al., 1988).

**Blood pressure**. Blood pressure was assessed with a Bonn Electrosphygmomanometer (Model No.3053287). This device consists of a standard cuff containing a Korotkoff sounds microphone and a microphone cable that is connected with the pump/recorder unit. Cuff inflation pressure was fixed and recordings could be made either visually or audibly, as the experimenter desired. All readings were made visually.

**Skill aquisition**. Learning the criterion motor skill was assessed by a pursuit rotor apparatus (Lafayette Instrument Co., Model No.30014) which measured the subjects ability to follow a rotating light. Rotating at a speed of 50 revolutions per minute (rpm), performance was recorded as time-on-target in milliseconds (msec). Each trial in the cognitive stress session was timed with a millisecond timer (Lafayette Instrument Co., Model No.54014).

## Procedures

### Pre-testing

Students in the study were required to participate in an initial screening procedure. Upon arrival at the Human Performance Laboratory at the University of Wollongong, informed consent was obtained (see Appendix A) and a description of the study provided. The subject then completed the student version of the Jenkins Activity Survey. Next, the subject participated in the Aerobic Power Index (submaximal test) portion of the Tri-level Profile of General Fitness (Telford et al., 1988). The results were screened to determine the subjects' level of aerobic fitness. Only low aerobically fit subjects were included in the study. Low aerobic fitness was operationally defined as an Aerobic Power Index score equivalent to or below the mean of the "average" category as defined by Telford et al. (1988). The participants were also assessed on their lower back/hamstring flexibility with the sit and reach apparatus. Skinfolds, taken at seven sites, ascertained total body fat.

### Experimental Protocol

One week after initial screening, the subjects were randomly assigned to one of four groups in a counter balanced order of participation to eliminate any possible order effect. Berger, Friedmann and Eaton (1988) warn however that encouraging people to practise a stress reduction technique they have little interest in is "nearly impossible". It is recommended that selection of

subject stress reduction activity be based on client
preferences (Berger, Friedmann and Eaton 1988). It was
decided however that personality variables in combination
with a variety of stress reduction techniques
necessitated random selection.

Upon entering the research laboratory, each subject
was informed of the testing procedures (see Appendix B).
A Sports Tester was then attached to the subject which
recorded heart rate (HR) every 15 seconds for the entire
experimental period. Prior to the treatment, subjects
were requested to remain seated for three minutes. This
period allowed adequate time to record baseline
physiological measures. A variety of reading material
was provided to help relax the subject.

At the conclusion of the resting period, systolic
and diastolic blood pressure were assessed. The
subject's current mood state was then recorded upon
completing the Profile of Mood States (POMS) using the
"right now" response set. When the subject completed the
initial POMS, the confederate entered the laboratory.
The subject was informed that they were to compete
against the confederate, the outcome of which would
determine their group assignment. Written general
instructions were then read simultaneously to the subject
and confederate (Appendix C). The subject and
confederate then competed on the pursuit rotor task for
five trials.

To induce stress, two pursuit rotor machines were prepared on separate tables with a partition separating them. This prevented competitors evaluating each others performance and eliminated any interaction between the subject and the confederate. During the competitive session, the subject tried to remain on target longer than the opponent, who was a confederate of the investigator. Three female sport psychology undergraduate students who were familiar with the pursuit rotor and had been instructed as to the protocol of win/loss ratios served as confederates. Three confederates were used because the investigation involved too many hours of work for one person, but all received similar training so that they could perform similarly in the experiment. Previous research has also found several confederates necessary (Karteroliotis and Gill, 1987). To help control possible contamination of data by using more than one confederate the confederate and subjects were not acquainted prior to the study and were discouraged from interacting during the experiment.

The competitors were signaled to begin when the investigator triggered on auditory cue. A distributed practise protocol was utilised for the five trials with a work rest schedule of 20 seconds each. No pre test practise trials were experienced. Based on bogus feedback offered by the experimenter, the subject "lost" four out of five trials in the first of the two sets of five trials, rather than informing the subject she had "won" the other trial, the confederate was informed she had "lost".

After the initial five trials, the subjects blood pressure (systolic and diastolic) was immediately assessed. Both the confederate and subject were then asked to complete another POMS before beginning the second set of five trials, the subject was asked to improve her concentration due to excessive "losing". The subject's poor performance record was also re-read to both the subject and the confederate (see Appendix D). During the second half of the stress period, five additional trials were completed, with the confederate again winning four out of the five attempts. The subject's blood pressure (systolic and diastolic) was recorded at the conclusion of the tenth trial and the subject then completed a third POMS inventory.

At the conclusion of the 10-week treatment period almost identical procedures of pre-test scores existed for post-test recordings. It was anticipated that subjects would become familiar and increasingly comfortable with the primary investigator over the intervention period and consequently any potential stressful effect in response may have been contaminated. Consequently, a confederate was trained to deliver negative bogus performance feedback in the same manner as offered during the pre-intervention trials.

### Treatments

Subjects in the exercise, yoga and placebo groups met with the investigator at least once a week for the entire ten weeks. (The experimenter served as the leader for all groups except in the yoga treatment where a

specialist instructor led the group; the experimenter was present however whenever any group met). The yoga and placebo groups met on separate days of the week for ten weeks at the University Sports Lounge and music auditorium, respectively. The placebo group met with the instructor prior to each music session and the instructor led a short post mortem at the conclusion of each performance. Subjects in the exercise group had a choice of a possible 10 exercise class times in which to accumulate the required four exercise sessions a week. All exercise sessions were led by the investigator at the University gymnasium. To eliminate frequency bias, yoga subjects were allocated a 30 minute taped yoga relaxation practise that they were instructed to listen to independently, four times a week. Total treatment time was equivalent between the exercise and yoga treatments. Compliance with the treatment was also monitored. Participation by the placebo, exercise and yoga subjects at group meetings was recorded and the yoga subjects were required to submit weekly diaries that documented their participation.

Moderate aerobic exercise group. The subjects in this group were required to exercise four times a week in an attempt to maximise aerobic gains (Astrand and Rodahl, 1986). The exercise involved a twenty station exercise class comprised of ten universal weight training stations and ten aerobic/floor stations. Universal weight training equipment represents guided resistance training

which permits the user to adjust the weight lifted. A number of body parts were exercised via the equipment. The equipment was positioned to exercise various parts of the body consecutively and so maximise aerobic training benefits due to consequent blood shunting effects. The ten aerobic/floor stations included two bicycles, two rebounders for jogging, two step up boxes, two skipping ropes and two floor stations for abdominal work.

Participation at each exercise station lasted 30 seconds. A buzzer sounded when it was time for subjects to change stations. The transition time between stations was included within this time period. The class was stopped at 10 and 20 minutes during exercise to determine individual radial pulse heart rates. This procedure was completed within 30 seconds which still permitted subjects to monitor their aerobic based exercise intensity - between 65 to 90 percent of the subject's predicted maximum heart rate (American College of Sports Medicine, 1986). The exercise duration was 30 minutes, followed by 10 minutes of stretching instructed by the investigator. The circuits were conducted specifically for the aerobic exercise group at the University and times were offered that permitted all subjects to satisfy exercise frequency and duration requirements.

Satyanda yoga group. Yoga nidra is a systematic method of inducing complete physical, mental and emotional relaxation (Saraswati, 1984). It is part of

the Satyanda yoga method of attaining "union" or "joining together" of body, emotions and mind. Satyanda yoga uses similar techniques to Hatha yoga, the exercise version of yoga, which is composed of stretching, a focus on muscle relaxation and breathing routines (Berger and Owen, 1988). It was utilised in this investigation because Hatha yoga alone has been found to significantly decrease anxiety, depression, anger, fatigue and confusion (Berger and Owen, 1988).

The Satyanda yoga group was guided through these techniques in the morning on the same day of the week for 10 weeks before any University classes had commenced. Early morning practise times were suggested by the Satyanda yoga practitioner to maximise concentration on the yoga techniques, as previously recommended (Saraswati, 1984). Each weekly meeting began with an attendance check and collection of adherence diaries. The Satyanda yoga practitioner then led the group, including the investigator, through a 10 minute yoga nidra practise. Half an hour of stretching and balancing techniques followed interspersed and concluding with various breathing practises. A longer 20 minute yoga nidra practise concluded the hour long session. The Satyanda yoga practitioner led the entire practise and answered any subject questions regarding technique. No questions regarding expected outcomes were answered other than suggesting such questions would be answered at the conclusion of post testing.

Each group member was also supplied with a 30 minute, taped yoga nidra practise similar to that which concluded each Instructor led Satyanda yoga session. Previously, no significant differences in electromyogram (EMG) or cognitive measures such as an Adapted Speech Anxiety Hierarchy (Hamberger and Schuldt, 1986) have been recorded between subjects receiving live versus taped relaxation instructions (Hamberger and Schuldt, 1986). Subjects were consequently requested to listen to the taped yoga nidra progression four other times weekly. A frequency of five practise sessions a week (one instructor led and four taped yoga nidra progressions) was equivalent to Benson's (1975) earlier recommendations for practising to promote the elicitation of the Relaxation Response. The consequent total time spent by the exercise and yoga subjects in their respective treatments was one hundred and sixty minutes a week.

Placebo group. This group required subjects to meet weekly during lunch at which time performances were provided by the School of Creative Arts at the University of Wollongong. The performances ranged from poetry readings to jazz guitar recitals (see Appendix E). The placebo group, helped to determine whether mood is altered by the non-specific effects of mere group participation, as suggested by Long (1984).

Several investigations have also contrasted exercise training with treatment conditions designed to control for subject expectancies (McCann and Holmes, 1984; Goldwater and Collis, 1985; Moses et al., 1989). These expectancy effects represent subjects recording positive mood alterations independently of treatment effects. Most recently, Moses et al. (1989) compared the effects of high and moderate intensity aerobic exercise on chronic and short term mood alterations and found no psychological benefits in the additional attention-placebo condition. The placebo group in the present investigation also helped eliminate subject expectancy contaminations. Eating lunch has been previously utilised as a control group when analysing the effects of a single bout of exercise (Wilson, Berger and Bird, 1981), and was found to reduce short term stress.

Control group. The no-treatment control group completed the motor task without being placed in a contrived competitive situation; that is, they completed the task in isolation without receiving any performance feedback. Otherwise, identical testing procedures were maintained when assessing the groups motoric abilities. Subjects in this group did not participate any further in the investigation until they completed an identical procedure ten weeks after pretesting. As this group did not receive the acute cognitive stressor, group results were utilised to establish the arousing effects of simply completing the motor task. Berger and Owen (1988) in

their comparison between aerobic exercise, Benson's Relaxation Response, and group interaction on stress reduction in college students, found chronic mood alterations independently of any specific treatment. Due to the lack of any treatment, the control group helped provide information as to whether repeated administration of the POMS alone resulted in significant chronic and acute mood alterations.

## Research Design and Statistical Analyses

The design of this study was a 3 (baseline, stress periods 2 and 3) x 4 (treatment conditions) x 2 (pre and post-intervention) factorial. This design served to compare the effects of an active and a passive stress management program on the ability of subjects to cope with acute stress. Figure 1 displays a flow chart representation of the design.

The analysis of the data was separated into three separate sections: (a) preliminary analyses, (b) treatment effects, and (c) correlational measures.

### Preliminary Analyses

One-way analyses of variance (ANOVAs) comparing the characteristics of the four treatment groups indicated whether the four groups differed before treatment according to anthropometric (body mass, total body fat, flexibility, and aerobic fitness) and behavioural (Jenkins Activity Survey (JAS) Type A and Impatience) measures.

```
┌─────────────────────────────────────────────────────────────────┐
│                  PRE-INTERVENTION ANTHROPOMETRIC                  │
│                  AND BEHAVIOURAL CHARACTERISTICS                 │
│                                                                  │
│  - Body Mass        - Flexibility       - Type A Behaviour       │
│  - Total Body Fat   - Aerobic Fitness   - Irritable and Impatient│
│                     - Competitiveness                            │
└─────────────────────────────────────────────────────────────────┘
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┌─────────────────────────────────────────────────────────┐
│                     PRE-INTERVENTION                     │
│                ACUTE STRESS ADMINISTRATION               │
│                                                          │
│             Trials      Stress     Trials     Stress     │
│  Baseline   ───────     Period     ───────    Period     │
│             1 → 5       No.2       6 → 10      No.3       │
└─────────────────────────────────────────────────────────┘
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┌──────────────────────────────────┐
│             10-WEEK              │
│          INTERVENTIONS          │
│                                  │
│  - Aerobic Exercise   - Placebo  │
│  - Satyanda Yoga      - Control  │
└──────────────────────────────────┘
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┌─────────────────────────────────────────────────────────────────┐
│                 POST-INTERVENTION ANTHROPOMETRIC                 │
│                 AND BEHAVIOURAL CHARACTERISTICS                 │
│                                                                  │
│  - Body Mass        - Flexibility       - Type A Behaviour       │
│  - Total Body Fat   - Aerobic Fitness   - Irritable and Impatient│
└─────────────────────────────────────────────────────────────────┘
```

```
┌─────────────────────────────────────────────────────────┐
│                    POST-INTERVENTION                     │
│                ACUTE STRESS ADMINISTRATION               │
│                                                          │
│             Trials      Stress     Trials     Stress     │
│  Baseline   ───────     Period     ───────    Period     │
│             1 → 5       No.2       6 → 10      No.3       │
└─────────────────────────────────────────────────────────┘
```

**Figure 1: Flowchart Representation of the Research Design**

Further analyses of variance (ANOVAs) determined if any differences also existed between group basal somatic and cognitive stress measures of heart rate, blood pressure and POMS subscale scores. Competitiveness, goal and win orientations were also assessed in separate ANOVAs. These later analyses helped establish whether the subjects differed in competitiveness which may have affected their degree of reactivity to the stressor. Further preliminary analyses included a series of 4 (group) x 2 (baseline and stress period 3) analyses of variance (ANOVAs) with repeated measures calculated on heart rate and systolic and diastolic blood pressure initially, and then for the POMS subscale scores. The separate ANOVAs assessed the extent to which the subjects responded somatically and cognitively to the treatment. A final analysis determined whether subjects differed on motor learning in response to acute stress. A 4 (group) x 2 (trial blocks 1 and 5) with repeated measures on the last factor was completed on motor performance scores, where the trials were paired.

### Treatment Effects

Effects of the treatments on anthropometric and behavioural measures were examined by comparing pre and post-treatment scores using analyses of variance (ANOVAs). The respective intervention program's affect upon somatic and cognitive acute stress responses was examined in two three-factor MANOVAs. Two 4 (group) x 2 (pre and post-intervention) x 3 (baseline and stress

periods 2 and 3) MANOVAs with repeated measures on the last two factors were calculated initially on heart rate and systolic and diastolic blood pressure measures and secondly on the six mood subscale scores. A 4 (group) x 2 (pre and post-intervention) ANOVA also examined differences in absolute recovery heart rates as a function of the respective treatments. A final analysis assessed the degree to which acute stress effected subjects motor learning as a function of the respective interventions. A 4 (group) x 2 (trials blocks 1 and 5) ANOVA with repeated measures on the last factor was then completed on motor learning scores.

### Correlational Analyses

Pearson product-moment correlations were calculated between the somatic stress measures of heart rate and systolic and diastolic blood pressure. Secondly, correlations between somatic stress measures (heart rate, systolic and diastolic blood pressure) and cognitive responses (all six factors of the POMS) established the extent of the interrelationship between these dependent variables. Finally, Pearson product-moment correlations between motor learning and somatic and cognitive stress responses determined the extent to which the subjects' psychophysiological responses were related to learning a motor skill when exposed to acute stress.

## CHAPTER IV

## RESULTS

The effects of the treatments upon the subjects' physiological and psychological responses to stress, required contrasting measures obtained prior to and following the interventions. The heart rates were determined at five periods. A baseline assessment was recorded after an initial three minute rest period. Three measures were then noted during the stress treatment while subjects performed on the pursuit rotor: (1) immediately prior to the first trial, (2) at the end of the fifth trial and (3) directly after the tenth concluding trial. A final recovery measure was then obtained 45 seconds later (Holmes and Roth, 1985). Adjusted heart rate scores (adjusted score = stress period/recovery - baseline) were utilised in the present investigation, as recommended in the related literature (Holmes and Roth, 1985), to eliminate the effects of increments in cardiovascular fitness and consequent decreases in resting heart rate. For comparative purposes, absolute heart rates were also included when assessing the treatment effects upon heart rate responses to acute stress. All other somatic (systolic blood pressure and diastolic blood pressure) and cognitive acute stress response variables (Profile of Mood States, POMS) were recorded at a baseline and twice during stress administration (stress periods 2 and 3). These two

stress periods equate with the second and the third heart measures during the stress treatment, i.e. (2) at the end of the fifth trial and (3) directly after the tenth concluding trial. Absolute, as opposed to relative scores, were utilised to measure blood pressure, (Sherwood et al., 1989) while T-Scores served as the dependent variable for POMS (Berger and Owen, 1988).

Before determining whether the treatments influenced the subjects' cognitive, somatic and motoric responses to the acute stressor, it was necessary to determine: (1) whether differences existed in baseline group anthropometric (body mass, body fat, flexibility and aerobic fitness) and behavioural (Type A and Impatient scores) characteristics prior to the treatment, (2) if the groups were equivalent in their baseline acute stress response measures prior to the treatment, (3) whether the subjects who received the stressor were stressed prior to treatment, (4) whether the subjects adhered to their respective treatments during the experiment, (5) the effect of the treatments upon the anthropometric and behavioural group characteristics, and (6) the effect of the treatments upon long-term cognitive stress and resting cardiovascular measures. Univariate analyses were conducted on baseline measures followed by multivariate analyses of treatment effects after the adoption of a similar approach by previous multivariate stress researchers (Berger, Friedmann and Eaton, 1988). Significance was set at an alpha level of $p < 0.05$.

## Baseline Measures of the Group Characteristics

Prior to the administration of the treatments and the initial acute stress exposure, it was necessary to determine whether the groups differed in their anthroprometric characteristics and their Type A and Impatience scores. One-way analyses of variance (ANOVAs) comparing the four groups' baseline measures indicated that the groups did not differ according to body mass, $F(3,40) = 0.56$, $p>0.05$, body fat sum, $F(3,40) = 0.74$, $p>0.05$, flexibility, $F(3,40) = 0.20$, $p>0.05$ and aerobic fitness as estimated by the aerobic power index score of the Trilevel Fitness Test, $F(3,40) = 1.84$, $p>0.05$. Thus, subjects were statistically similar on the selected physiological variables prior to the treatment.

Mean scores for Type A or Type B behavioural characteristics were ascertained from the student version of the Jenkins Activity Survey (JAS). All subjects were classified as Type B, $F(3,40) = 1.13$, $p>0.05$. Mean Irritation and Impatient subcomponent scores on the JAS (student version) placed the subjects in the LOW category of this subcomponent as reported by Öhman et al. (1989) and, again, did not differ between groups.

Additional analyses were required to assess whether the groups differed in their competitiveness which, in turn, may have potentially effected the subjects' responses to the treatment. Analyses of variance

(ANOVAs) revealed no significant differences on the psychological measures of competitiveness, $F(3,40) = 0.46$, $p > 0.05$, and the additional measures of win-orientation, $F(3,40) = 0.81$, $p > 0.05$ and goal-orientation, $F(3,40) = 0.36$, $p > 0.05$. The group means on the competitive scale ($Ms$; exercise = 36.58 (9.12), yoga = 37.00 (6.26), placebo = 34.75 (10.32), control = 39.67 (13.16)) were below those measured by Gill (1986) for women participating in physical activity classes (mean = 45.60) and for men and women enrolled in noncompetitive exercise classes (mean = 44.50). All group means on the win-orientation and goal-orientation scores in the present investigation were also below those of the exercising women and men measured by Gill (1986). Overall, then, the groups did not differ in competitiveness. Table 1 summarises the characteristics of the subjects.

## Baseline Measures of Acute Stress Responses

Group differences in baseline measures on the adjusted heart rate, systolic blood pressure and diastolic blood pressure scores and total POMS and subcomponent scores in response to acute stress were also tested for significance. In particular, individual ANOVAs revealed that groups did not differ according to baseline levels of heart rate $F(3,40) = 1.04$, $p > 0.05$ and systolic blood pressure, $F(3,40) = 0.57$, $p > 0.05$. However, the groups varied significantly between resting

## TABLE 1

### BASELINE MEASURES OF
### PHYSIOLOGICAL, BEHAVIOURAL, AND PSYCHOLOGICAL CHARACTERISTICS OF ALL GROUPS

| | Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Exercise (n=12) | | Yoga (n=8) | | Placebo (n=12) | | Control (n=12) | |
| Characteristic | M | SD | M | SD | M | SD | M | SD |
| Body Mass (kg) | 63.12 | 11.88 | 61.24 | 4.06 | 66.66 | 8.72 | 62.76 | 5.62 |
| Body fat sum (mm) | 137.77 | 40.23 | 114.67 | 20.38 | 130.33 | 37.81 | 133.34 | 34.15 |
| Flexibility (cm) | 4.83 | 11.48 | 3.87 | 10.27 | 5.50 | 8.36 | 6.92 | 5.32 |
| Aerobic Power Index (w/kg) | 1.49 | 0.16 | 1.52 | 0.24 | 1.47 | 0.21 | 1.63 | 0.12 |
| Competitiveness | 36.58 | 9.12 | 37.00 | 6.26 | 34.75 | 10.32 | 39.67 | 13.16 |
| Win | 15.67 | 5.68 | 17.25 | 3.89 | 14.08 | 5.53 | 16.92 | 5.35 |
| Goal | 21.58 | 5.33 | 22.12 | 5.22 | 21.25 | 3.17 | 23.00 | 3.77 |
| Type A score (JAS) | 33.75 | 26.98 | 34.37 | 18.98 | 20.67 | 14.64 | 30.00 | 16.51 |
| Irritation (JAS) | 21.32 | 5.06 | 19.17 | 3.07 | 20.37 | 4.67 | 19.18 | 5.60 |
| Heart rate (bpm) | 82.67 | 13.06 | 84.62 | 15.24 | 89.67 | 14.68 | 80.17 | 11.94 |
| Systolic Blood Pressure (mm/Hg) | 107.42 | 12.69 | 109.37 | 13.55 | 108.67 | 18.10 | 102.50 | 8.91 |
| Diastolic Blood Pressure (mm/Hg) | 73.00 | 12.34 | 71.00 | 10.47 | 63.33 | 11.39 | 59.67 | 9.53 |
| Tension | 10.17 | 5.47 | 10.12 | 3.98 | 8.83 | 5.95 | 6.00 | 4.04 |
| Depression | 6.08 | 4.17 | 9.62 | 5.32 | 4.75 | 6.14 | 3.42 | 3.94 |
| Anger | 9.33 | 6.58 | 9.50 | 6.72 | 3.25 | 2.93 | 2.50 | 2.61 |
| Vigour | 12.75 | 4.92 | 10.12 | 4.12 | 11.75 | 4.75 | 19.75 | 6.78 |
| Fatigue | 7.83 | 3.13 | 13.87 | 5.74 | 8.33 | 6.23 | 7.33 | 8.46 |
| Confusion | 6.50 | 3.20 | 10.00 | 4.99 | 9.17 | 4.61 | 6.75 | 7.68 |
| Total Mood Disturbance | 27.17 | 19.82 | 43.00 | 21.31 | 22.50 | 25.03 | 3.75 | 27.27 |

levels of diastolic blood pressure, $F(3,40) = 3.69$, $p<0.02$ and initial combined POMS subscale, (Total Mood Disturbance, TMD) scores, $F(3,40) = 4.63$, $p<0.007$.

The TMD score represents the sum of the six POMS subscales, weighting vigour negatively. The significant differences between the groups in their resting TMD scores necessitated further analyses to determine upon which subscales divergence existed. Separate ANOVAs were completed on individual POMS subscales and disclosed significant differences between the groups for anger, $F(3,40) = 6.49$, $p < 0.001$ and vigour, $F(3,40) = 6.97$, $p< 0.001$. Differences in group means for tension, $F(3,40) = 1.71$, $p>0.05$, depression, $F(3,40) = 1.89$, $p>0.05$, fatigue, $F(3,40) = 4.30$ $p>0.05$ and confusion, $F(3,40) = 1.07$, $p>0.05$ subscales were not significant. The group disparity in baseline measures in two of the six POMS subscales, anger and vigour, are similar to the baseline divergence in the vigour scale reported by Berger and Owen, (1988) in their longitudinal investigation utilising the POMS.

Analyses of all the baseline measures were conducted at an experimentwise error rate of $p<0.95(19 \times 0.05 = 0.95)$. Significant differences between groups upon baseline measures of physiological, behavioural and psychological characteristics therefore need to be addressed considering such a maximum level of experimentwise error.

## Pre-treatment Responses to the Stressor

After determining the existance of group differences on baseline levels of the acute stress response variables, it was necessary to ascertain the extent to which the subjects were stressed by the stressor. Stress influences were appraised by cognitive (POMS subscales), somatic (adjusted heart rate, systolic blood pressure and diastolic blood pressure) and motoric (pursuit rotor performance) response variables.

### Cognitive Responses

No group differences in baseline levels on the tension, depression, fatigue and confusion subscales were calculated. Therefore the effects of the stressor on the subjects' responses on these four variables were completed by a series of 4 (groups) x 2 (baseline and stress period 3) ANOVAs with repeated measures on the last factor. Stress period 3 represented the measure assessed directly after the tenth concluding trial.

Inspection of these data shows that subjects had significantly higher tension, $F(3,40) = 4.14$, $p < 0.05$ immediately after performing the task than directly prior to its initiation. The group x stress period interaction on the tension subscale was not statistically significant, $F(3,40) = 2.25$, $p > 0.05$. However, as the interaction approached significance, Fishers LSD technique (two-tailed) was employed to determine if any

group differences existed. Analyses indicated significantly lower tension at the conclusion of the tenth trial for the (no stress) control group in contrast to the placebo and yoga groups ($p < 0.05$). No other group comparisons in mean changes in the tension scores were statistically significant.

The post-hoc analyses above were considered only after a review of the pertinent statistical literature. Several authors suggest that LSD tests should only be performed if significant overall F-values are recorded (Tea, 1991; Holland, 1991). A recent report questioned the significance of the overall F-value and concluded that LSD post-hoc analyses were most justified in the absence of a significant overall F-value (Saville, 1991).

Such debate implies that consensus has not yet been reached by statisticans as to whether post hoc LSD tests should be conducted in the presence of an insignificant overall F-test. As the F-values in the present analysis were nearly significant the consequent post hoc LSD tests in the presence of an insignificant overall F-test were considered justified.

Initially, these results indicated that scores on the tension subscale were elevated immediately after the completion of the motor task. Furthermore, the tension subscale differentiated between subjects who completed

the motor task (control) without experiencing stress and those who received the acute cognitive stressor while completing the motor task (yoga and placebo). Thus, the yoga and placebo groups became increasingly more tense than the no-stress control group, apparently due to performing under a competitive condition and negative (bogus) feedback. The exercise group did not differ from any of the other groups on this measure.

Results indicated no baseline and stress period effects or group x baseline interactions on the subscales of fatigue, $F(1,40)$ = 0.49, $p>0.05$ $F(3,40)$ = 0.44, $p>0.05$, respectively, confusion, $F(1,40)$ = 0.001, $p>0.05$, and $F(3,40)$ = 1.74, $p>0.05$, respectively, or depression subscales, $F(1,40)$ = 3.34, $p>0.05$ and $F(3,40)$ = 0.85, $p>0.05$. Table 2 summarises the POMS subscale scores at stress periods 2 and 3.

Initial group differences were recorded for baseline levels of anger and vigor which needed to be considered when assessing the effects of the stressor upon these two components of POMS. For each of the variables anger and vigor, an analysis of covariance (ANCOVA) was completed on the change from baseline to stress period 3 pre intervention scores, using the baseline scores as a

## TABLE 2

### PRE-INTERVENTION POMS SUBSCALE RESPONSES TO ACUTE STRESS

| Characteristic | | Exercise (n=12) M | SD | Yoga (n=8) M | SD | Placebo (n=12) M | SD | Control (n=12) M | SD |
|---|---|---|---|---|---|---|---|---|---|
| Tension | - Stress Period 2 | 10.58 | 7.14 | 10.75 | 4.20 | 11.08 | 8.37 | 7.17 | 8.41 |
| | - Stress Period 3 | 10.08 | 6.12 | 12.37 | 7.23 | 11.83 | 8.85 | 5.75 | 6.12 |
| Depression | - Stress Period 2 | 8.08 | 8.10 | 11.87 | 9.43 | 4.67 | 5.24 | 5.75 | 9.06 |
| | - Stress Period 3 | 8.17 | 7.54 | 9.75 | 7.83 | 6.58 | 8.48 | 3.42 | 5.84 |
| Anger | - Stress Period 2 | 8.50 | 8.36 | 9.50 | 7.39 | 3.58 | 2.64 | 3.42 | 4.40 |
| | - Stress Period 3 | 10.17 | 8.88 | 8.62 | 8.31 | 4.42 | 3.20 | 3.75 | 6.56 |
| Vigour | - Stress Period 2 | 13.00 | 4.37 | 9.75 | 4.86 | 11.50 | 5.60 | 19.25 | 7.40 |
| | - Stress Period 3 | 11.50 | 4.30 | 8.37 | 5.15 | 9.00 | 5.22 | 18.92 | 7.10 |
| Fatigue | - Stress Period 2 | 6.17 | 3.81 | 14.12 | 7.47 | 7.50 | 5.68 | 7.25 | 9.31 |
| | - Stress Period 3 | 6.58 | 3.80 | 13.87 | 6.81 | 8.42 | 6.26 | 7.25 | 9.28 |
| Confusion | - Stress Period 2 | 7.50 | 3.58 | 8.87 | 4.32 | 8.25 | 4.05 | 6.00 | 8.29 |
| | - Stress Period 3 | 8.58 | 3.29 | 10.12 | 5.22 | 8.50 | 5.31 | 5.33 | 7.10 |

covariate. The analyses showed no significant differences for anger across stress periods, $\underline{F}(3,39)$ = 0.97, $\underline{p}>0.05$, or vigour, $\underline{F}(3,39)$ = 1.41, $\underline{p}>0.05$. Therefore of the six POMS subscales, only tension was significantly altered between stress periods for groups.

## Physiological Responses

The influence of the acute stressor upon somatic response variables was ascertained to determine the extent to which the stressor affected the subjects' arousal level. As indicated earlier baseline levels of heart rate and systolic blood pressure were found not to differ between groups. Consequently, a 4 (group) x 2 (stress periods 1 and 3) ANOVA with repeated measures on the last factor was computed on adjusted heart rate scores (where adjusted heart rate was equal to stress period minus baseline). Stress period 1 represents the measurement directly prior to initiating the first trial. The results of the analysis revealed that subjects, in general, had reliably higher pulse rates at the conclusion of the motor task as compared to immediately prior to administration of the acute stressor, $\underline{F}(1,40)$ = 49.43, $\underline{p}<0.001$ ($\underline{M}s$ = 6.04 (6.52) and 19.34 (8.27), respectively). The overall mean absolute heart rate at stress periods 1 and 3 were 84.25 (10.88) beats per minute (bpm) and 103.59 bpm (11.81) bpm. The groups x stress-period interaction was not significant, $\underline{F}(3,40)$ = 1.39, $\underline{p}>0.05$. These heart rate responses suggest that all groups increased their heart rate by merely

completing the motor task as opposed to participating on the task as well as receiving the bogus negative feedback. As the (no stress) control group did not significantly differ from the stressed treatment groups in their adjusted heart rate responses to acute stress, it would appear the combination of performing the motor task in a competitive situation with bogus negative feedback did not significantly alter the subjects' heart rate.

A 4 (groups) x 2 (baseline and stress period 3) ANOVA with repeated measures on the last factor also was computed for systolic blood pressure. It was revealed that at the conclusion of the motor task, subjects had significantly higher systolic blood pressure as compared to levels prior to the initiation of the task, $\underline{F}(1,40)$ = 3.68, $\underline{p}<0.02$. A significant group x stress period interaction was also recorded, $\underline{F}(3,40)$ = 3.68, $\underline{p}<0.02$. Fishers LSD technique (two-tailed), computed to ascertain the direction of the differences among the groups, revealed the control group had significantly lower systolic blood pressure than all other groups at the conclusion of the motor task ($\underline{p}<0.05$). Thus, acute somatic stress responses expressed as systolic blood pressure, were highest in the three groups which received the mental stressor while completing the motor task.

At baseline, as indicated earlier, the groups were found to differ significantly in their diastolic blood pressure scores. An analysis of covariance (ANCOVA) was therefore completed on the change from baseline to the

third stress period, occuring immediately after the completion of the tenth performance trial, for pretreatment acute stress responses, using the baseline scores as a covariate. The regression on the covariate was not significant $\underline{F}(1,39)$ = 1.44, $\underline{p}>0.05$, but the difference between groups was $\underline{F}(3,39)$ = 3.06, $\underline{p}<0.05$. Comparisons of the group means (adjusted for the covariate) were made. It was found that the adjusted mean of the control group was significantly lower than that of the placebo ($\underline{p}<0.02$) and the exercise groups ($\underline{p}<0.02$). The differences between all other pairs of adjusted means were statistically similiar ($\underline{p}<0.05$). It was determined the diastolic blood pressure responses to acute stress, prior to treatment, were similar to the systolic blood pressure responses. That is, the change in diastolic blood pressure from baseline to immediately after the tenth trial, was lower in the control group as compared to two the placebo and exercise groups. Table 3 graphically illustrates the somatic and TMD responses at the second and third stress periods.

### Motor Learning

**Pre-treatment.** Motor learning on the pursuit rotor over the first set of ten trials was averaged into five blocks of two trials. Thus, the first block consisted of the average of the first two trials, while block 5 represented the average of trials 9 and 10. Since at the pretreatment stage, the induced arousal effect of

TABLE 3

PRE-INTERVENTION PHYSIOLOGICAL AND TOTAL MOOD DISTURBANCE
RESPONSES TO ACUTE STRESS

| Characteristic | Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Exercise (n=12) | | Yoga (n=8) | | Placebo (n=12) | | Control (n=12) | |
| | M | SD | M | SD | M | SD | M | SD |
| Adjusted | | | | | | | | |
| Heart Rate - Stress Period 2 | 15.67 | 13.20 | 17.50 | 10.57 | 21.08 | 10.42 | 22.25 | 10.49 |
| - Stress Period 3 | 19.67 | 11.51 | 12.87 | 11.65 | 22.83 | 9.74 | 20.83 | 11.52 |
| Absolute | | | | | | | | |
| Heart Rate - Stress Period 2 | 98.33 | 9.51 | 102.12 | 19.75 | 110.75 | 19.47 | 102.42 | 9.99 |
| - Stress Period 3 | 101.33 | 9.89 | 97.50 | 18.09 | 112.50 | 16.74 | 101.00 | 11.43 |
| Systolic | | | | | | | | |
| Blood Pressure - Stress Period 2 | 109.75 | 9.72 | 117.62 | 8.07 | 110.92 | 17.84 | 106.50 | 15.14 |
| - Stress Period 3 | 111.50 | 11.34 | 114.37 | 10.06 | 108.00 | 14.01 | 97.00 | 13.17 |
| Diastolic | | | | | | | | |
| Blood Pressure - Stress Period 2 | 76.17 | 14.26 | 72.12 | 14.56 | 66.83 | 8.16 | 58.75 | 14.20 |
| - Stress Period 3 | 75.17 | 15.76 | 67.00 | 15.89 | 66.50 | 9.07 | 53.67 | 11.31 |
| Total | | | | | | | | |
| Mood Disturbance- Stress Period 2 | 28.08 | 27.98 | 45.37 | 28.48 | 24.00 | 27.07 | 24.00 | 27.07 |
| - Stress Period 3 | 32.00 | 26.30 | 46.37 | 31.93 | 30.75 | 30.25 | 30.75 | 30.25 |

competition and bogus negative feedback had only just begun (Block 1), the motor performance of all treatment conditions was expected to be equal. This was evident by the lack of significant differences among the four groups based on the results of a one-way ANOVA, $F(3,40) = 1.10$, $p > 0.05$.

A 4 (groups) x 2 (trials) ANOVA with repeated measures on the last factor was completed on the first and last trial blocks to determine if groups differed in motor performance in response to the stressor. All subjects were found to have reliably better performance at the conclusion of the fifth trial block than directly after the first trial block, $F(1,40) = 141.76$, $p < 0.0001$ ($Ms = 4.85$ (6.65) and 10.66 (4.86) msec, respectively). These results are presented in Table 4. Since the group x trials interaction was nonsignificant $F(3,40) = 1.40$, $p > 0.05$, the extent of learning was statistically the same for all groups.

## Adherence to the Treatment

As indicated earlier, after experiencing acute stress, subjects were assigned to their respective treatment groups. In addition guidelines were provided indicating the yoga students were to meet the criteria of practicing yoga a minimum of five days a week as recommended by Saraswati (1984). All exercisers were to maintain a minimum of three days a week exercise (Berger

## TABLE 4

### PRE AND POST-INTERVENTION SKILL ACQUISITION SCORES

| | Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Exercise (n=12) | | Yoga (n=8) | | Placebo (n=12) | | Control (n=12) | |
| Characteristic | M | SD | M | SD | M | SD | M | SD |
| Pre-Intervention | | | | | | | | |
| Trial Block 1 | 4.51 | 2.68 | 6.66 | 3.65 | 4.44 | 2.68 | 4.38 | 3.55 |
| Trial Block 5 | 10.13 | 3.77 | 11.84 | 5.20 | 12.14 | 3.40 | 8.92 | 4.90 |
| | | | | | | | | |
| Post-Intervention | | | | | | | | |
| Trial Block 1 | 9.19 | 3.55 | 9.25 | 3.97 | 11.77 | 4.15 | 9.24 | 4.86 |
| Trial Block 5 | 11.12 | 3.05 | 13.13 | 4.11 | 14.41 | 4.39 | 10.48 | 3.88 |

and Owen, 1988). Dropouts from the investigation were comprised of subjects who: (1) chose not to continue the treatment, (2) missed more than two consecutive group meetings, or (3) were absent for more than five independent practice sessions as recorded in their diaries. The actual number and percentage of dropouts in each technique were as follows: placebo, one of 13 (7.7%), control, 1/13 (7.7%), exercise, 1/13 (7.7%), and yoga 4/12 (25%). These dropout percentages are similar to those reported by Berger, Friedmann and Eaton (1988), however in the present study the yoga group did have a higher subject dropout than all other groups.

To determine whether there were significant differences in the frequency of dropout rate between the groups, a Chi Square analysis was computed. Significant differences among groups, $\underline{X}^2$ = 13.09, $\underline{p}$<0.01, indicated that the yoga group did experience a significantly higher dropout rate than all other groups. Overall, then, all groups reported dropout rates of 25% or less as reported in previous studies (e.g., Berger and Owen, 1988). However, the yoga group experienced significantly less adherence to the treatment than all other groups, a dropout rate which was higher than the 17.7% recorded by a group practising 12 weeks of Benson's Relaxation Response (Berger, Friedmann and Eaton, 1988).

## Treatment Effects Upon Selected Characteristics of Subjects

The influences of the respective treatments upon group anthropometric (body mass, total body fat, flexibility and aerobic fitness) and behavioural (Type A and Impatience scores) characteristics represented the initial analyses to determine the effects of the interventions. A 4 (groups) x 2 (prepost intervention) ANOVA with repeated measures on the last factor was calculated on the aerobic power index scores prior to and at the conclusion of the treatments. An inspection of the data disclosed a significant effect for cardiovascular fitness, $F(3,40) = 50.97$, $p<0.0001$ as well as a significant group x prepost interaction, $F(3,40) = 4.31$, $p<0.01$. Fishers LSD technique (two-tailed) was completed to ascertain the direction of the differences among the conditions. The post hoc analyses indicated that the change in aerobic fitness for the exercise group (0.41W/kg) was significantly greater than that of the other three groups ($p<0.05$). There were no significant differences among the yoga (0.20W/kg), placebo (0.13W/kg), and control groups (0.16W/kg) on the mean change of their aerobic fitness scores. The resultant group mean for Aerobic Power Index scores placed all post-intervention means within the "average" range of aerobic fitness for women 14 to 35 years of age (1.6 - 2.1W/kg) (Telford et al., 1988). Consequently, the aerobic exercise treatment was the only intervention to

significantly alter pre intervention cardiovascular fitness levels, however the change was not large enough to label the exercisers as having "very good" aerobic fitness levels (Telford et al., 1988).

Similar 4 (groups) x 2 (prepost intervention) ANOVAs with repeated measures on the last factor were completed on the mean change scores from baseline pre-intervention to resting post-intervention on the other selected group characteristics. Results showed no significant effects or interactions on the mean change scores of body mass, $F(3,40) = 1.01$, $p > 0.05$, body fat, $F(3,40) = 0.67$, $p > 0.05$, and flexibility, $F(3,40) = 1.11$, $p > 0.05$. Furthermore, the interventions had no significant effect on group mean Type A score, $F(3,40) = 0.51$, $p > 0.05$ or the Irritable and Impatient subcomponent scores, $F(3,40) = 1.03$, $p > 0.05$. In retrospect, the only group characteristic to be significantly altered by the treatment was the significant elevation of aerobic fitness in the exercise group. All other anthropometric (body mass, body fat sum and flexibility) and behavioural characteristics (Type A, and Irritable and Impatient subcomponent scores derived from selected questions of the JAS) were not significantly altered by the interventions. Resting levels for all measures are presented in Table 5.

It was predicted in this study that exercise and yoga would lead to decreases in long-term stress levels as measured by the Profile of Mood States (POMS). Long-

## TABLE 5

## POST-INTERVENTION RESTING MEASURES OF PHYSIOLOGICAL, BEHAVIOURAL AND PHYSIOLOGICAL CHARACTERISTICS OF ALL GROUPS

| Characteristic | Exercise (n=12) M | Exercise (n=12) SD | Yoga (n=8) M | Yoga (n=8) SD | Placebo (n=12) M | Placebo (n=12) SD | Control (n=12) M | Control (n=12) SD |
|---|---|---|---|---|---|---|---|---|
| Body Mass (kg) | 61.58 | 12.79 | 61.42 | 6.81 | 63.97 | 7.65 | 60.80 | 8.71 |
| Body fat sum (mm) | 132.58 | 40.76 | 110.50 | 24.30 | 120.88 | 41.54 | 130.25 | 37.74 |
| Flexibility (cm) | 8.33 | 8.15 | 3.62 | 8.80 | 6.75 | 10.31 | 8.25 | 4.11 |
| Aerobic Power Index (w/kg) | 1.90 | 0.29 | 1.72 | 0.33 | 1.60 | 0.32 | 1.79 | 0.23 |
| Type A score (JAS) | 35.00 | 25.13 | 28.75 | 23.57 | 18.75 | 11.31 | 24.17 | 17.56 |
| Irritation (JAS) | 22.01 | 8.07 | 19.65 | 7.02 | 20.04 | 10.76 | 18.29 | 4.36 |
| Heart rate (bpm) | 74.17 | 8.71 | 83.87 | 10.88 | 89.17 | 9.52 | 80.67 | 11.88 |
| Systolic Blood Pressure (mm/Hg) | 101.50 | 13.57 | 112.50 | 14.76 | 107.33 | 15.87 | 100.17 | 10.03 |
| Diastolic Blood Pressure (mm/Hg) | 55.67 | 15.74 | 54.00 | 8.88 | 59.33 | 15.76 | 57.25 | 11.35 |
| Tension | 5.00 | 2.60 | 11.75 | 8.76 | 8.00 | 5.24 | 8.00 | 7.03 |
| Depression | 3.92 | 2.64 | 11.50 | 12.27 | 4.58 | 6.10 | 5.58 | 7.77 |
| Anger | 4.50 | 3.29 | 9.12 | 10.19 | 4.50 | 3.99 | 6.42 | 5.88 |
| Vigour | 18.67 | 4.83 | 13.62 | 5.60 | 13.50 | 4.17 | 21.50 | 8.11 |
| Fatigue | 5.42 | 3.50 | 10.00 | 4.78 | 8.50 | 5.42 | 8.92 | 9.80 |
| Confusion | 5.50 | 1.93 | 10.50 | 7.87 | 6.75 | 4.16 | 6.42 | 6.04 |
| Total Mood Disturbance | 5.67 | 10.60 | 36.50 | 48.81 | 18.83 | 23.17 | 13.83 | 41.63 |

term stress was defined as the change in pre-intervention baseline mood state, as compared to, resting mood profile prior to acute stress administration at the conclusion of the training period.  Therefore, to determine if long-term cognitive stress reductions eventuated due to the treatments, baseline pre intervention and resting post intervention mood profiles needed to be compared.

A 4 (groups) x 2 (baseline, pre and post-intervention) ANOVA with repeated measures on the last factor was calculated on resting POMS subscale measures. Results showed a significant group by pre-post interaction on baseline measures of tension, $\underline{F}(3,40)$ = 3.83, $\underline{p}<0.02$.  The maximum experimentwise error was $\underline{p}<0.20(4 \times 0.05 = 0.20)$.  The effect of the interventions on tension are summarised in Figure 2.

It is evident that the largest reductions in tension were reported by subjects in the moderate aerobic exercise condition.  This pattern was confirmed by breakdown contrast analyses in which the long-term decreases in tension shown by the moderate aerobic exercise group were significantly different from that seen in all other conditions.  The other groups did not differ.  It would appear, therefore, that long-term stress reduction as measured by the tension variable was evident only under the moderate aerobic exercise condition.  Lack of a significant groups x pre-post treatment interaction showed that no long-term stress reductions were recorded for fatigue, depression or confusion.
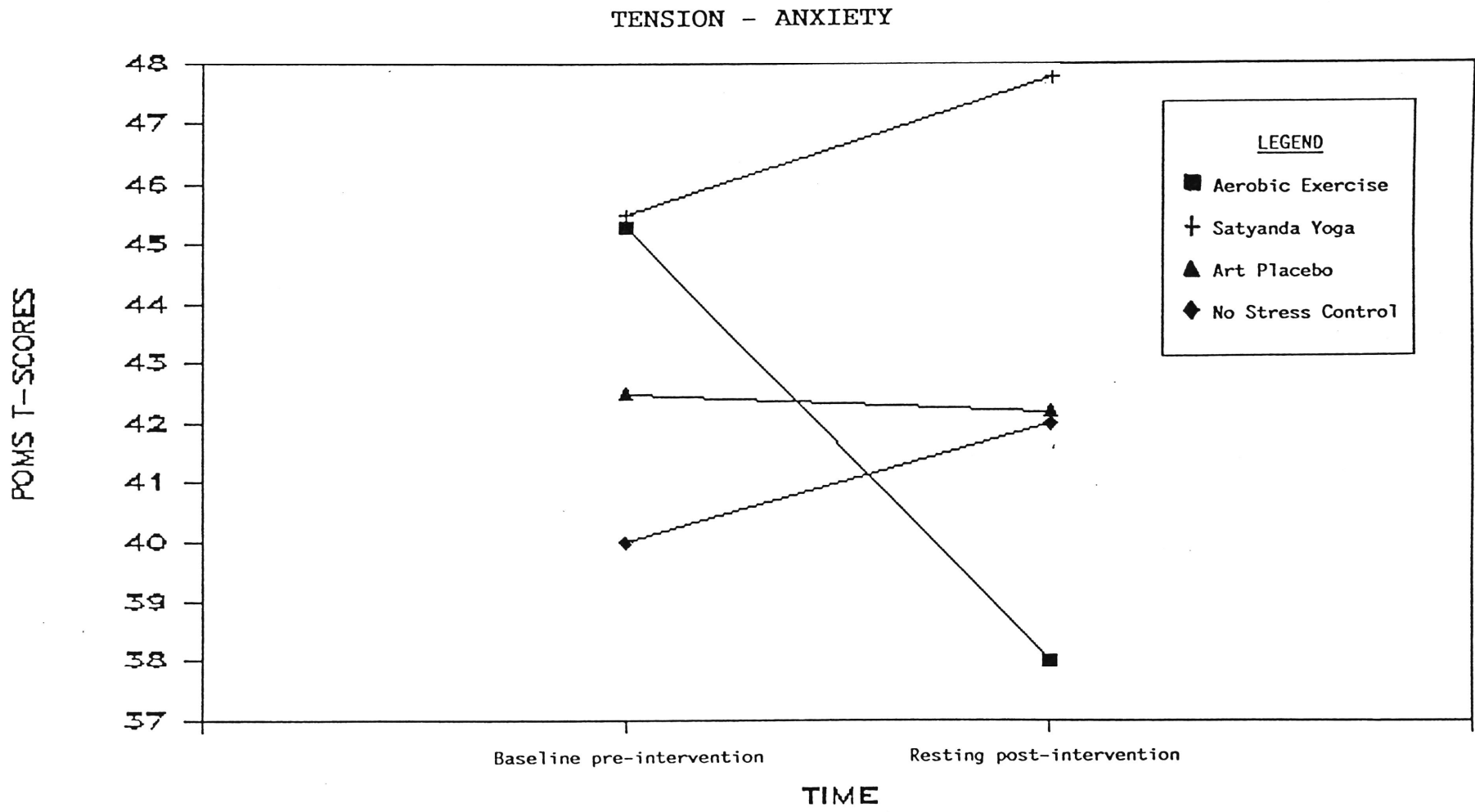
FIGURE 2: Tension/anxiety T-scores on the POMS for the four experimental conditions prior to acute stress administration at pre and post-intervention

Repeated measures analysis of covariance (ANCOVA) using change scores from baseline pre-intervention to resting post-intervention as the dependent measure and covarying for initial group differences were completed for those subscales which reported initial group differences at baseline pre-intervention. No significant differences between groups nor over time were reported in the analyses for anger and vigor. Thus, only the exercise group reported significant decreases in resting levels of mood state on any POMS variable. It was concluded that only exercise promoted selected long-term stress reduction as measured on the tension subscale of the POMS.

## Treatment Effects Upon Baseline Somatic Stress Measures

Aerobic exercise treatment increased the subjects' cardiovascular fitness which in turn, may have changed resting heart rate and blood pressure. A series of 4 (group) x 2 (pre-post intervention) ANOVAs with repeated measures on the last factor were conducted to examine the effects of the stress treatment on adjusted pre-stress heart rates and systolic blood pressure. The pre-post effect was not significant for pre-stress measures of adjusted heart rate $\underline{F}(1,40 = 1.94$, $\underline{p}>0.05$, nor for systolic blood pressure $\underline{F}(1,40) = 1.21$, $\underline{p}>0.05$. Also the group x pre-post interaction did not attain significance for either of the two variables, $\underline{F}(3,40) = 0.07$, $\underline{p}>0.05$,

and $F(3,40) = 0.88$, $p > 0.05$, respectively. Consequently, the treatments did not significantly effect resting levels of adjusted heart rate or systolic blood pressure.

Initial differences between groups prior to the treatment were recorded for the diastolic blood pressure measure. The change in diastolic blood pressure from baseline at pre-intervention to the resting period after the intervention was consequently examined, using the initial baseline pretreatment scores as a covariate. Initial covariate tests, however, revealed there was no significant effects for the covariate. Consequently a one-way ANOVA was performed on the unadjusted diastolic blood pressure recordings and showed a significant group x pre-post interaction, $F(3,40) = 5.37$, $p < 0.01$. The diastolic blood pressure effect is summarised in Figure 3.

Post hoc analyses showed that the decreases in the exercise and yoga groups' diastolic blood pressures were significantly different from that of the placebo and control conditions, but not between each other ($p < 0.01$ for all comparisons). Therefore, the largest reductions in diastolic blood pressure were reported by subjects in the moderate aerobic exercise and Satyanda yoga groups. Overall, the only significant effects of the treatments upon baseline measures of somatic acute stress response variables were the moderate aerobic exercise and Satyanda yoga decreases in resting diastolic blood pressure.
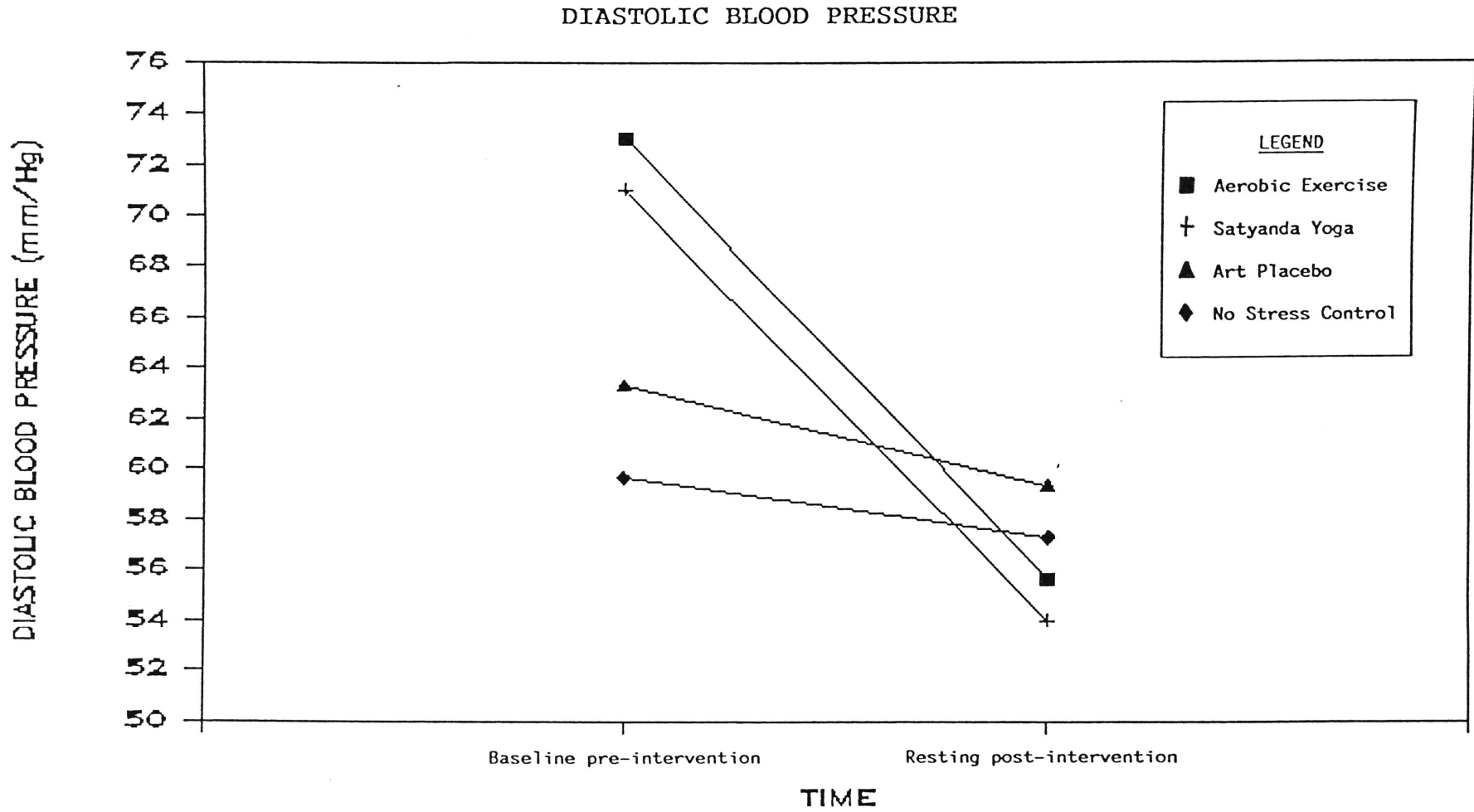
DIASTOLIC BLOOD PRESSURE



FIGURE 3: Mean diastolic blood pressure scores for the four experimental conditions at baseline pre-intervention and resting post-intervention

## Treatment Effects Upon Acute Stress Responses

Having established the treatment effects upon group cognitive, behavioural and physiological characteristics, the effects of the treatment upon acute stress reactivity were addressed. Acute stress responses were measured by cognitive, somatic, and motoric variables.

### Cognitive Responses to Acute Stress

Prior to assessing the treatments effect upon cognitive acute stress responses however, the extent to which groups were equated at resting levels post intervention was ascertained. One-way analyses of variance (ANOVAs) were conducted on the resting POMS subscale scores at post-intervention and revealed significant differences between groups for tension, $F(3,40) = 3.71$, $p < 0.04$, depression, $F(3,40) = 2.93$, $p < 0.05$, vigor, $F(3,40) = 4.93$, $p < 0.01$, fatigue, $F(3,40) = 3.99$, $p < 0.03$ and confusion, $F(3,40) = 3.62$, $p < 0.04$. The differences in group means for anger were not significant, $F(3,40) = 1.27$, $p > 0.05$. All significant differences recorded for individual POMS subscale measures were moderated by a maximum experimentwise error of $p < 0.22(2 \times 0.04 + 1 \times 0.03 + 1 \times 0.01 + 2 \times 0.05 = 0.22)$. Of note, such maximum measures represent a theoretical extreme level of significant error and should be treated as such when significant differences were reported.

The post-intervention resting POMS differences, in combination with the baseline pre-intervention POMS subscale differences, meant that all of the six POMS subscales reported group differences at pre-intervention baseline or post-intervention rest. Therefore, to compare the acute stress response of pre- to post-intervention, these initial differences were covaried.

A separate multivariate analysis of covariance (MANCOVA) on each of the six POMS subscales was completed where the response variables were the change score from baseline/rest to the conclusion of the tenth trial (stress period 3). The cognitive responses to the acute stressor at stress periods 2 and 3 are presented in Table 6.

Initial preliminary analyses revealed that no covariate slope to control for baseline differences was required for the fatigue and confusion subscale and that a common slope would suffice for tension, depression and anger. The test to see if a different covariate slope was needed for the vigor subscale was significant ($p < 0.05$). However, rather than apply a separate covariate to the vigor subscale only, it was determined in the interests of uniformity, a common covariate slope would be used for all six subscales.

# TABLE 6

## POST-INTERVENTION POMS SUBSCALE RESPONSES TO ACUTE STRESS

| Characteristic | | | Group | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Exercise (n=12) | | Yoga (n=8) | | Placebo (n=12) | | Control (n=12) | |
| | | | M | SD | M | SD | M | SD | M | SD |
| Tension | - | Stress Period 2 | 6.08 | 2.81 | 13.00 | 9.24 | 8.50 | 4.77 | 7.92 | 9.38 |
| | - | Stress Period 3 | 6.17 | 3.54 | 14.12 | 11.22 | 9.92 | 5.85 | 6.58 | 8.09 |
| Depression | - | Stress Period 2 | 3.75 | 4.20 | 12.50 | 14.28 | 3.75 | 5.14 | 6.42 | 9.70 |
| | - | Stress Period 3 | 4.25 | 3.89 | 14.37 | 19.39 | 4.58 | 6.47 | 5.83 | 8.65 |
| Anger | - | Stress Period 2 | 12.83 | 27.37 | 11.50 | 13.12 | 3.75 | 3.16 | 5.33 | 6.00 |
| | - | Stress Period 3 | 4.91 | 2.75 | 13.75 | 17.35 | 4.50 | 4.60 | 6.33 | 8.56 |
| Vigour | - | Stress Period 2 | 17.66 | 5.68 | 12.00 | 6.00 | 12.25 | 4.86 | 20.58 | 8.92 |
| | - | Stress Period 3 | 16.33 | 4.62 | 11.00 | 5.55 | 11.75 | 5.14 | 21.08 | 8.53 |
| Fatigue | - | Stress Period 2 | 3.66 | 2.93 | 9.75 | 5.34 | 9.00 | 6.78 | 8.67 | 10.31 |
| | - | Stress Period 3 | 4.75 | 2.93 | 10.75 | 8.27 | 10.25 | 6.21 | 8.17 | 10.72 |
| Confusion | - | Stress Period 2 | 5.83 | 2.33 | 10.87 | 8.93 | 7.17 | 3.95 | 6.08 | 6.80 |
| | - | Stress Period 3 | 5.41 | 1.79 | 10.87 | 8.72 | 9.00 | 5.81 | 6.08 | 7.19 |

The overall analysis showed a significant group x month interaction for both the anger, $F(3,39) = 4.33$, $p < 0.01$, and confusion subscales, $F(3,39) = 3.45$, $p < 0.026$. For anger a significant regression effect was calculated for between-subjects, $F(1,39) = 7.87$, $p < 0.008$. However, because the interaction was within-subjects and changes at pre-intervention with those at post-intervention for each subject were compared, the significant regression was ignored in making group comparisons. This data, presented as change scores are summarised in Figure 4.

A non-parametric Kruskal-Wallis test was completed on the four groups because the assumptions for using ANOVA did not apply, as shown by a significant result from Box's M-test for sphericity (Box, 1953). For anger, the equality of the effects of the four groups was not significant, $X^2(3,0.1) = 6.25$, $H$(observed value) $= 6.49$, $p > 0.05$. However, due to the significance of the test when lowered to the alpha level of $p < 0.10$, and considering the previous review of pertinent literature stating that consensus has not yet been reached by statisticans regarding post-hoc procedures for observed values approaching conventional levels of significance, a one-way ANOVA was conducted to help clarify the results and indicated a significant groups x pre-post interaction, $F(3,39) = 3.45$, $p < 0.01$. Kruskal-Wallis tests were therefore completed on subsets of the groups. The effect of the yoga treatment upon the anger responses to acute stress administration were significantly greater
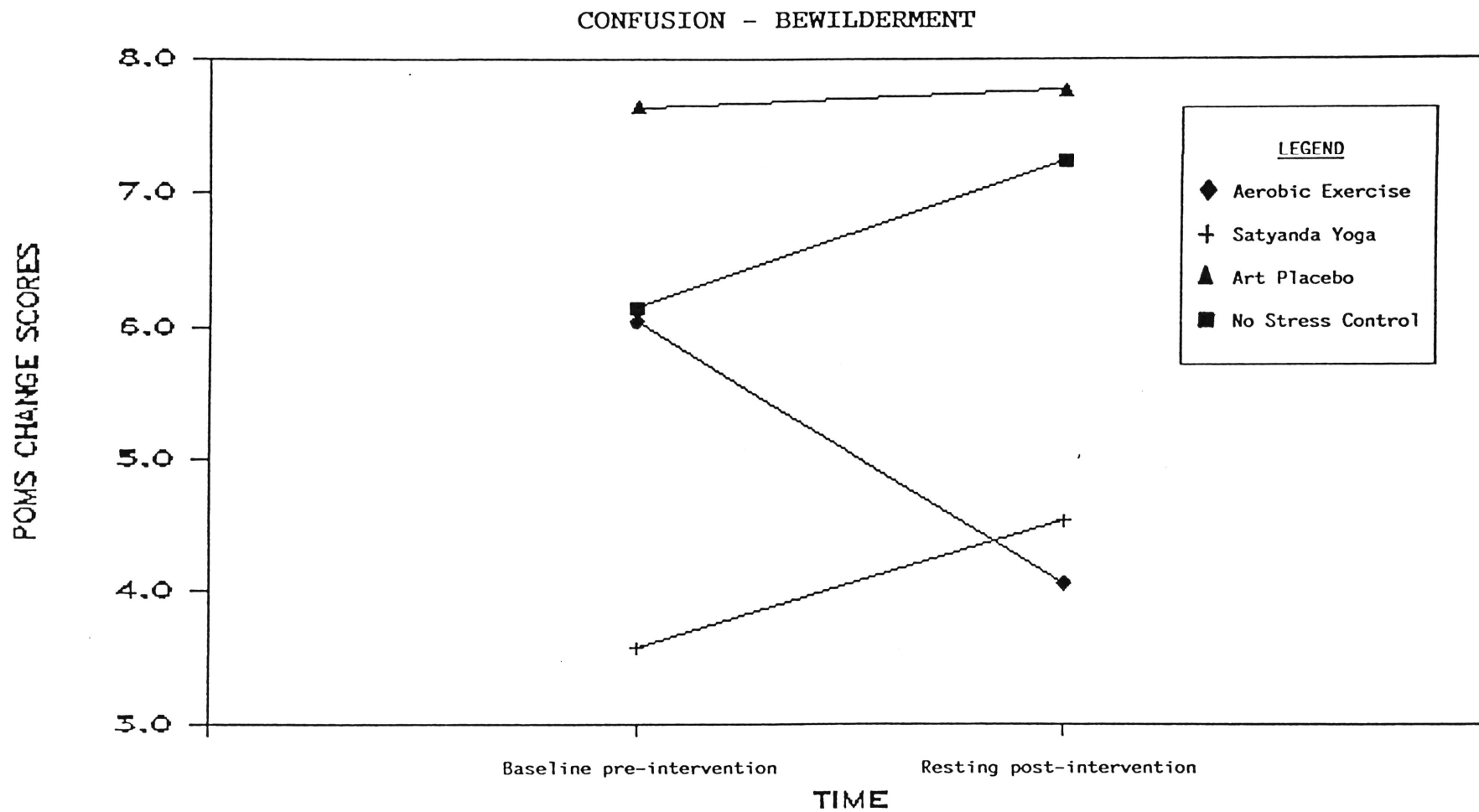
CONFUSION - BEWILDERMENT



FIGURE 4: Confusion/bewilderment change scores (stress period 3 - baseline) on the POMS for the four experimental conditions at pre and post-intervention

($p < 0.05$) than the anger responses of the placebo and control groups, but was not significantly greater than the exercise group's anger expression. There was no significant differences between the effects of the exercise, placebo and control group on short-term anger responses.

In assessing the effects of the treatments on the confusion subscale, a significant regression on the covariate at the within-subjects level needed to be addressed $F(1,39) = 37.18$, $p < 0.001$. The only other significant effect for the confusion subscale was the group x month interaction, $F(3,39) = 3.45$, $p < 0.03$. However as the interaction effect was also at the within-subjects level, each difference score needed to be adjusted by the appropriate multiple of the covariate before comparing the observations for all four groups. The adjustment procedure is required because the significant regression on the covariate, influences the group x month interaction. The difference scores are presented in Figure 5 with the results plotted as adjusted change scores (stress period 3 - baseline + baseline x constant, for pre and post-intervention).

A non-parametric Kruskal-Wallis test found the effects of the four groups were significantly different $X^2(3,3.025) = 9.35$, $H = 10.50$, $p < 0.025$. Kruskal-Wallis tests on subsets of the data found the confusion responses of the exercise group were significantly less
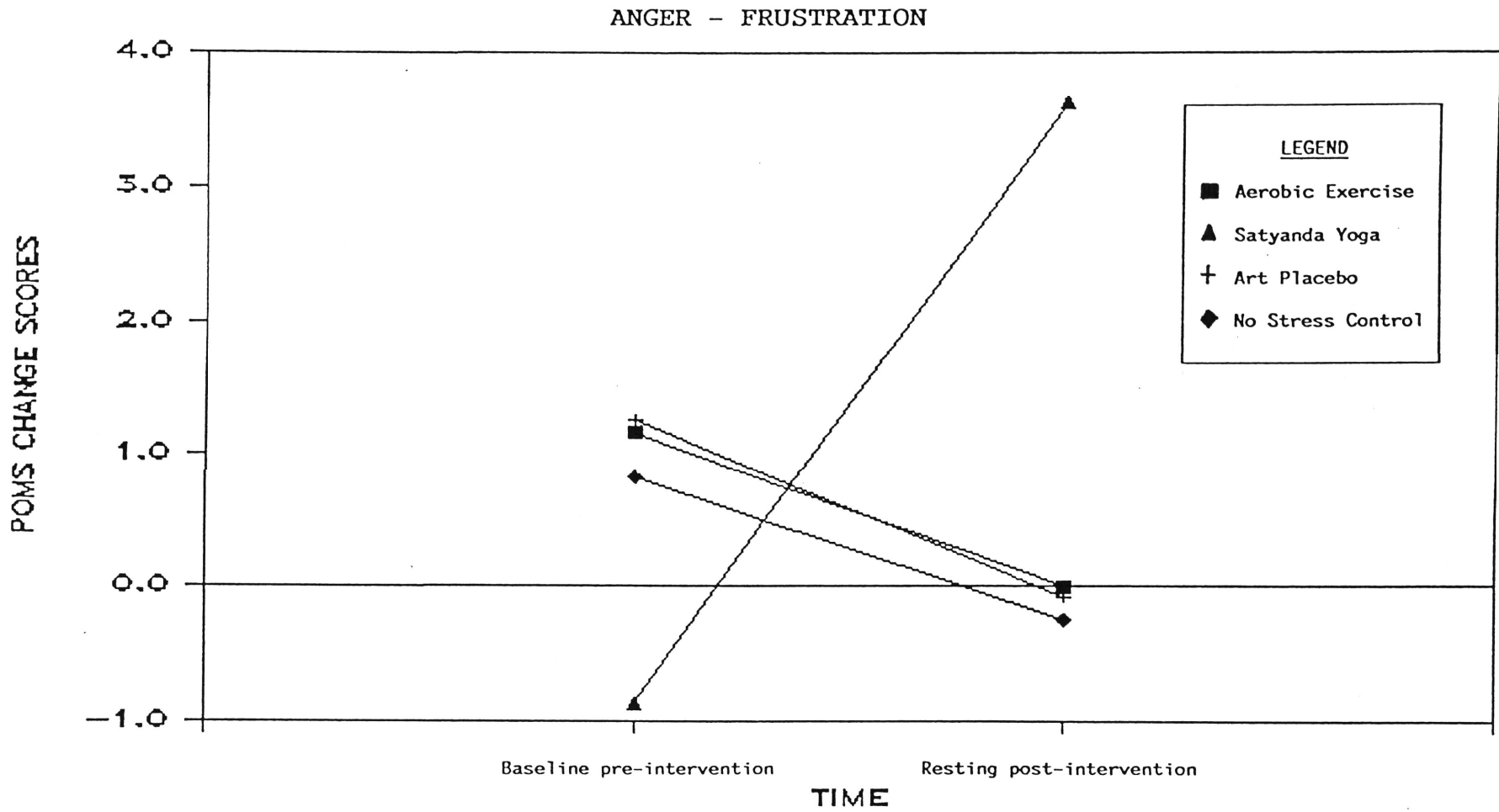
ANGER – FRUSTRATION

FIGURE 5: Anger/frustration change scores (stress period 3 – baseline) on the POMS for the four experimental conditions at pre and post-intervention

than those of the placebo and control group ($p < 0.05$). There were no significant differences between expressed confusion in response to an acute mental stressor between the aerobic exercise and satyanda yoga groups ($p > 0.05$). Furthermore, there were no significant differences between the effects of the yoga, placebo and control groups in confusion responses to acute stress ($p > 0.05$). Significant between-subject covariate regression effects were recorded for the tension and depression subscales. However, no group x pre-post interaction for either tension, $F(3,39) = 1.06$, $p > 0.05$, depression, $F(3,39) = 1.63$, $p > 0.05$, vigor, $F(3,39) = 0.73$, $p > 0.05$, or fatigue, $F(3,39) = 0.76$, $p > 0.05$, subscales were found ($p > 0.05$). Table 7 presents the post-intervention somatic and TMD responses to acute stress at stress periods 2 and 3.

## Somatic Responses to Acute Stress

A 4 (group) x 3 (baseline and stress periods 2 and 3) x 2 (pre and post-intervention) MANOVA was computed to examine the adjusted heart rate and systolic blood pressure responses to acute stress. Pillai's test for significance was utilised to determine significance. Results showed a significant group x stress period interaction, $F(18,111) = 0.73$, $p < 0.02$, as well as a significant group x prepost intervention interaction, $F(9,120) = 2.23$, $p < 0.02$. The three way interaction between group, stress period and prepost intervention was not significant, $F(18,240) = 0.81$, $p > 0.05$. Consequently,

## TABLE 7

### POST-INTERVENTION PHYSIOLOGICAL AND TOTAL MOOD DISTURBANCE
### RESPONSES TO ACUTE STRESS

| | Group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Exercise (n=12) | | Yoga (n=8) | | Placebo (n=12) | | Control (n=12) | |
| Characteristic | M | SD | M | SD | M | SD | M | SD |
| **Adjusted** | | | | | | | | |
| Heart Rate - Stress Period 2 | 16.58 | 9.25 | 21.50 | 15.59 | 23.58 | 10.59 | 21.50 | 7.86 |
| - Stress Period 3 | 19.75 | 12.08 | 18.50 | 12.11 | 19.92 | 8.66 | 20.92 | 11.44 |
| **Absolute** | | | | | | | | |
| Heart Rate - Stress Period 2 | 90.75 | 14.01 | 105.37 | 15.85 | 112.75 | 16.72 | 102.17 | 10.28 |
| - Stress Period 3 | 93.92 | 11.19 | 102.37 | 12.98 | 109.08 | 13.10 | 101.58 | 10.76 |
| **Systolic** | | | | | | | | |
| Blood Pressure - Stress Period 2 | 103.16 | 15.80 | 110.50 | 15.59 | 105.83 | 22.70 | 105.00 | 13.76 |
| - Stress Period 3 | 100.83 | 12.37 | 109.75 | 8.71 | 103.83 | 18.81 | 98.50 | 7.73 |
| **Diastolic** | | | | | | | | |
| Blood Pressure - Stress Period 2 | 57.67 | 11.78 | 52.75 | 8.07 | 58.83 | 9.12 | 55.42 | 11.89 |
| - Stress Period 3 | 52.00 | 12.93 | 47.25 | 13.22 | 60.17 | 13.06 | 53.67 | 11.96 |
| **Total** | | | | | | | | |
| Mood Disturbance- Stress Period 2 | 7.00 | 14.45 | 45.62 | 53.46 | 20.96 | 22.15 | 13.83 | 48.50 |
| - Stress Period 3 | 9.00 | 15.03 | 52.87 | 66.92 | 26.50 | 24.99 | 11.92 | 48.47 |

the groups differed as to their reaction to the stressor and in their mean changes in at least one of the variables after the treatment.

Univariate analyses were then required on the two dependent variables, adjusted heart rate and systolic blood pressure, to determine upon which variables the interactions occurred. Consequent, univariate analyses on adjusted heart rate scores showed only a stress period significant effect, $F(2,39) = 45.10$, $p<0.0001$. This result reaffirmed that the motor task caused an increase in heart rate both before and after the intervention. The lack of a group x stress period effect, $F(6,80) = 1.75$, $p>0.05$ suggested that the subjects in the no stress control group who performed the motor task recorded similar increases in adjusted heart rate as those subjects in the groups which completed the task while competing with an experimental confederate and receiving bogus negative feedback (exercise, yoga and placebo groups).

A 4 (group) x 2 (pre-post intervention) ANOVA with repeated measures on the last factor was completed to examine the treatment effects on adjusted recovery heart rates. Results showed no main effect for adjusted heart rate, $F(1,40) = 1.03$, $p>0.05$ and a nonsignificant group x prepost intervention interaction, $F(3,40) = 1.17$, $p>0.05$. Therefore, in terms of adjusted heart rate, the predicted decrements in acute stress induced arousal from participation in the exercise treatment did not eventuate.

Univariate analyses for the systolic blood pressure recordings revealed a significant group x prepost interaction, $F(6,80) = 2.35$, $p < 0.04$. Post hoc analyses duplicated earlier findings to reveal that the control group had recorded significantly lower blood pressure at the conclusion of the tenth trial on the pursuit rotor apparatus when averaged over the pre and post-intervention stress periods ($p < 0.05$). The significant pre-post, $F(1,40) = 4.90$, $p < 0.03$ main effect represented a decrease in systolic blood pressure recordings over the duration of the study. A somatic acute stress response as measured by systolic blood pressure therefore remained unchanged after the 10-week intervention period.

Finally, diastolic blood pressure in response to acute stress was analysed to determine if subjects were affected by the exercise treatment. The initial group differences at baseline prior to commencement of the treatment served as a covariate when comparing the diastolic blood pressure reactions to the acute stressor. A 4 (group) x 2 (pre-post intervention) ANCOVA with repeated measures on the last factor was completed where the change scores from baseline to stress period 3, pre and post-intervention, were the response variables. Results indicated no significant pre-post effect $F(1,39) = 2.68$, $p > 0.05$, nor a significant group x month effect, $F(3,39) = 0.56$, $p > 0.05$. Diastolic blood pressure acute stress responses also remained unchanged after the 10-week intervention.

## Absolute Heart Rates

To determine post-intervention overall arousal increments due to the stressor, it was necessary to also document absolute heart rate acute stress responses. Results of a one-way ANOVA on resting heart rates at post intervention was significant, $F(3,40) = 4.43$, $p<0.008$. Post hoc analyses found the exercise group had a significantly lower resting heart rate than the placebo and yoga groups ($p<0.05$). No other between group comparisons were significant ($Ms$; exercise = 74.16 (8.91) bpm, yoga = 83.75 (10.02) bpm, placebo = 89.17 (5.67) bpm, and control = 80.67 (9.63) bpm).

Therefore, it appeared the exercise training program decreased subject resting heart rate levels significantly more than the yoga and placebo treatments. No group differences were reported for post-intervention resting heart rates. These results suggest that the absolute reductions in heart rate in response to acute stress were eliminated for persons who increased their cardiovascular fitness, after controlling for the contaminating effect of modified baseline heart rates.

To determine if differences in absolute heart rate existed during or at recovery from stress, a series of one way ANOVAs were completed upon group heart rate responses for each of the three stress period measures, as well as at recovery. Significant differences between groups were not evident at any of the three stress

periods ($p > 0.05$). However, a significant result was found for the recovery measure, $\underline{F}(3,40) = 120.6$, $\underline{p} < 0.0001$. In particular, Fishers LSD post hoc analyses showed the exercise groups mean recovery heart rate was significantly lower than the yoga and placebo groups ($\underline{p} < 0.05$). The control group was also significantly lower than the placebo group. No other group differences were significant ($\underline{M}$s; exercise = 77.33 (8.26) bpm, yoga = 94.37 (12.20) bpm, placebo = 95.75 (15.20) bpm, and control = 86.17 (6.67) bpm).

Trends in absolute heart rate responses throughout the stress period were similar to the significant differences found at resting and recovery after the intervention. That is, exercise training significantly reduced overall heart rate responses when compared to the yoga and placebo groups. As well, the no stress control group did not evince as large an absolute heart rate response throughout the task as the placebo and yoga groups. Therefore, although responding with a larger absolute heart rate, the control group were not significantly different from the exercise group in their absolute heart responses throughout the procedure.

## Motor Learning

It was thought that exposure to acute stress would increase the subjects' physiological arousal, but that the exercise training program would reduce this effect. Similar changes were not predicted for the other groups. As a result, learning the motor skill during acute stress

was predicted to be inhibited by exercise training and to remain unchanged after participation in a yoga program. To examine the effect of acute stress on learning the motor task, after subjects experienced their respective interventions, averages of the first post intervention trial block for each group were compared. A one-way ANOVA between group measures of time-on-target showed there were no significant differences between the groups after the initial trial block post intervention, $F(3,40)$ = 1.08, $p>0.05$. As there were no differences between the no stress control group and the other three groups who received the acute stressor (exercise, yoga and placebo), these results implied that more than ten weeks after the initial learning period, acute stress did not inhibit learning.

A 4 (groups) x 2 (trials blocks) ANOVA with repeated measures on the last factor (trial blocks 1 and 5) was computed to determine if there were any differences among the learning scores of the groups at post intervention. Initially, the significant main effect of trials, $F(3,40)$ = 2.82, $p<0.05$ indicated a change over the five trials and Figure 6 shows that this was an improvement in learning by all three groups. The group x trials interaction was not significant at conventional levels, $F(3,40)$ = 1.65, $p>0.05$. No other between group comparisons were significant ($p>0.05$).
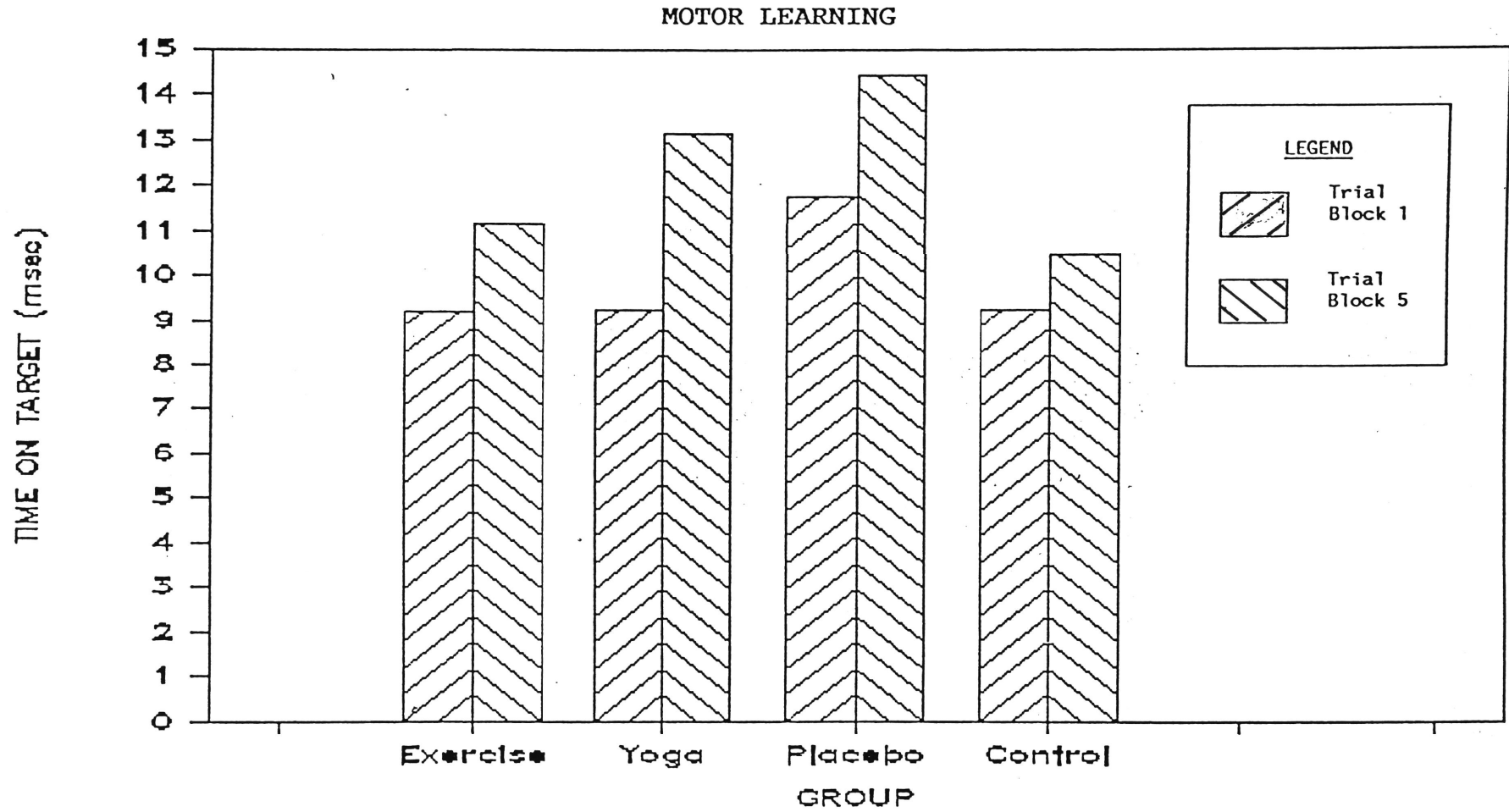
FIGURE 6: Time on target for the four experimental conditions for trial block 1 and trial block 5 at post-intervention

## Correlations

The present investigation assessed cognitive (POMS subscales), somatic (heart rate and blood pressure) and motoric (time on target) acute stress responses. Each area of responses has been primarily examined separately. To determine the relationships between the variables, the correlations between them were calculated.

Pearson product-moment correlations assessed the relationship between the three somatic acute stress response variables (heart rate, systolic blood pressure and diastolic blood pressure) at pre and post-intervention. A significant but low correlation was found between heart rate and systolic blood pressure at the conclusion of the tenth trial (stress period 3) during pre ($r$ = 0.28, $p<0.05$) and post intervention ($r$ = 0.30, $p<0.05$). No other relationships were significant. Therefore, somatic responses were mildly linked at the concluding stages of the acute stress administration.

Pearson product-moment correlations were computed between each motor performance variable (blocks 1 and 5) as well as the baseline and stress period 3 somatic (heart rate change scores, heart rate, systolic blood pressure and diastolic blood pressure) and cognitive acute stress measures (total mood disturbance). A significant moderate correlation was found between block

5 motor learning scores and absolute heart rate measures during the same stress period both pre ($r$ = 0.39, $p < 0.025$ and post ($r$ = 0.43, $p < 0.025$) intervention. The only other significant correlation was between block 1 motor learning scores and baseline total mood disturbance, prior to completing the treatments ($p < 0.05$).

Correlations between psychological (total mood disturbance) and physiological measures (heart rate, heart rate change scores, systolic and diastolic blood pressure) were also computed for both prior to and at the conclusion of the treatments. The Pearson product-moment correlations were computed between the four response variables, at baseline, directly after the fifth pursuit rotor trial (stress period 2) and at the conclusion of the tenth trial (stress period 3). Only one significant relationship was calculated at both pre and post-intervention. Heart rate and total mood disturbance scores exhibited a low inverse correlation at stress period 3, pre intervention ($r$ = -0.34, $p < 0.05$). A low correlation was also recorded between diastolic blood pressure and total mood disturbance ($r$ = -0.23, $p < 0.05$).

Finally, to assess the validity of the proposed long-term stress reduction relationship with short-term stress attenuation, the correlation between long-term (resting post intervention - baseline pre intervention) and short-term (stress period 3, post intervention -

resting, post intervention) cognitive stress was computed on each of the six POMS subscales and the Total Mood Disturbance scores. Pearson product moment correlations indicated that long-term and short-term stress responses were significant only on the confusion subscale where a low inverse correlation was reported ($r$ = -0.33, $p < 0.05$). Therefore, changes in short-term and long-term stress reduction were not related.

## CHAPTER V

## DISCUSSION

In the present study, an attempt was made to examine the effect of an active, moderate aerobic exercise, and a passive, satyanda yoga, stress management program upon reductions in chronic stress levels and consequent cognitive reactions to an acute cognitive stressor. Another objective in this investigation was to compare the degree to which the two stress management programs effected cardiovascular responses to acute mental stress. The consequences of altering arousal responses to acute mental stress, were then measured in terms of the influences level of arousal has upon motor learning. To this end, several hypotheses were generated in which stress responses, as a function of experimental conditions, were predicted. They are presented in order of reference.

## Long-Term Cognitive Stress Reduction

Based on Profile of Mood State (POMS) scores, students who participated in the active stress reduction activity of moderate aerobic exercise, reported a significant decrease in long-term tension. The decrease in long-term stress levels of tension supported the prediction of a significant decrease in long-term

cognitive stress levels after the 10-week program of moderate aerobic exercise. The lack of any significant reductions in long-term stress levels from the yoga program participants was in conflict with the predicted changes. It was predicted that decreases in long-term stress levels would eventuate in subjects who participated in a 10 week treatment program of Satyanda yoga. The lack of comprehensive long-term stress reduction on all subscales may be indicative of the debate as to whether stress management programs result in attenuation of long-term stress levels (Berger and Owen, 1988).

Exercise induced reductions in long-term stress levels of tension have been a consistent finding (Blumenthal et al., 1982; Moses et al., 1989), and less consistently reductions in long-term measures of fatigue (Blumenthal et al., 1982) and confusion (Moses et al., 1989). Yogic breathing has been found to promote long-term reductions in tension, fatigue and depression as well as increased vigor (Harvey, 1983). Reductions in long-term stress levels for POMS profiles have also been refuted (Berger and Owen, 1983, 1988). In the present study long-term stress reduction eventuated on the tension subscale, and increasingly this measure appears to be particularly representative of long-term cognitive stress reduction.

## Psychological Responses to Acute Stress

As hypothesized, students who participated in the moderate aerobic exercise program also reported a significant decrease in confusion as measured by the POMS. However, in contrast to the predicted decreases in overall cognitive acute stress responses, Satyanda yoga subjects reported a significant increase in acute anger responses. The conflicting results between the exercise and yoga groups for the confusion and anger POMS subscale measures is indicative of the various combinations of positive mood changes that have been recorded by several authors directly after exercise. Reductions in confusion have been recorded by subjects immediately after single bouts of aerobic-orientated swimming (Berger and Owen, 1988) and jogging (Berger, Friedman and Eaton, 1988). However, no subscale of the POMS has been representative of reduced short-term cognitive stress. In fact, positive short-term changes in all POMS subscales have been reported (Iaonne, 1988).

It was hypothesized that stress management induced long-term stress reductions would, in turn, moderate detrimental effects of acute stress on cognitive responses. That is, long-term stress reduction was predicted to attenuate short-term mood change in response to an acute stressor. In the present investigation, prior to initiation of the respective treatment programs the tension subscale on the POMS was the only

psychological measure to increase significantly. The tension scale was also the only subscale which differentiated between those subjects who completed the motor task without exposure to stress (control group) and subjects in the other groups who were exposed to the stress condition. A significant decrease in long-term cognitive stress was found on the tension subscale only. Therefore, if the long-term/short-term stress reduction relationship existed, post-intervention tension acute stress responses should have been reduced. This was not the case.

Furthermore, the only significant relationship between long-term and short-term stress was the negative correlation reported on the confusion subscale ($r$ = -0.33, $p<0.05$). That is, as long-term stress decreased, short-term confusion responses increased. No other correlations between long-term and short-term stress responses attained significance. Alternative mechanisms for the long-term and short-term acute stress reductions are limited by the variables considered in the investigation. However, one such mechanism may be aerobic fitness.

Assessment of aerobic fitness in the present study was determined by the aerobic portion of the Trilevel fitness test. This technique is more reliable than other submaximal cardiovascular fitness ergometry tests (Telford, 1989) as a fitness score and consequent fitness

change. The aerobic portion of the Tri-level assessment can be completed without extrapolating data onto nomograms (Astrand, 1986). An analysis of the treatment effects upon anthropometric characteristics (i.e., body mass, body fat, flexibility and aerobic fitness) revealed that moderate aerobic exercise was the only treatment that precipitated change in any of the variables. This included a significant increase in cardiovascular fitness which placed the aerobic exercise group above the mean of the "average" category of cardiovascular fitness status as determined by Telford et al. (1988). The exercise group was the only treatment to exceed "average" cardiovascular fitness at the post-test, according to the Trilevel fitness test used in this study. Nonetheless, the significant positive changes in long-term and short-term stress responses indicated that improved psychological state can eventuate from moderate aerobic exercise in persons with little exercising history and low cardiovascular fitness.

Previously, the only investigation to record changes in subjective responses to an acute psychological stressor as a function of cardiovascular fitness was conducted by comparing aerobically trained versus untrained subjects (Sinyor et al., 1983). No differences in acute stress responses were recorded during stress. However, 15 minutes after stress administration, State Anxiety scores for trained subjects decreased significantly. The relationship between significant

decreases in cognitive stress and significantly lower recovery heart rate were also noted. Other investigations have found no significant decreases in short-term mood profile in response to acute psychological stress with increases in subject cardiovascular fitness (Holmes & McGilley, 1987; Sinyor et al., 1986). Low correlations have also been noted between improvement in cardiovascular fitness and cognitive changes in responses to psychological acute stress (Sinyor et al., 1986). The present investigation recorded low correlations between physiological and psychological response to acute stress. That is, the changes in cognitive response variables did not appear to be strongly related with somatic responses. Low relationships between physiological and psychological variables is common (Karteroliotis & Gill, 1984).

Moses et al., (1989) found positive psychological responses in subjects who participated in moderate aerobic exercise, but not for those in high exercise or attention-placebo conditions. These authors concluded psychological responses to exercise training are not due to expectancies of stress reduction or other features inherent in structured activity, but only emerge when an aerobic exercise component is also present. Further, the positive results attained from moderate aerobic exercise as opposed to the high intensity exercise program were hypothesized as a function of engaging in, what subjects thought was, an enjoyable form of activity. This

permitted subjects to achieve levels of physical activity that they had previously perceived as too difficult without exerting undue effort (Moses et al., 1989). In the present investigation, personal communication with subjects in the moderate aerobic exercise condition supported such feelings of self-mastery. Several subjects attained various physiological goals previously thought unachievable such as "touching the toes with straight legs". Although no significant increases in the measures of flexibility, body fat sum or body mass were reported, numerous investigations have shown an increase in the subject's perceptions of self-mastery after aerobic training (Long, 1984; Sinyor et al., 1986).

Berger and Owen (1988), in their attempted taxonomy of exercise to induce positive psychological change, suggested a non-competitive environment, repetitive rhythmical activity, and predictability were necessary exercise requirements to reduce short-term stress. The Satyanda yoga and the moderate aerobic activity conditions satisfied these criteria. However, positive mood changes eventuated only from the moderate aerobic exercise group. In earlier research, Hatha yoga participants have felt significantly less tension, depression, fatigue, confusion and anger directly after a yoga class (Berger and Owen, 1988). Greater decreases in state anxiety have also been reported in middle grade students after completing a yoga meditation class than a control group of magazine reading (Kalayil, 1988).

However, the few investigations examining the psychological effects of yoga techniques have concentrated upon mood changes directly after class participation as opposed to following exposure to acute stress.

In the present investigation several factors may have contributed to the increase in anger by the Satyanda yoga subjects after experiencing stress. These include home practise and consequent poor practise adherence and random assignment. Although random assignment was considered essential in the present experiment, encouraging people to practise a stress reduction activity in which they have little interest was difficult. Since the ability to reduce stress depends on compliance with the stress management procedure, Berger et al. (1988) has recommended that selection of stress reduction activity should be based on client preferences. For example, if a client finds Satyanda yoga unsatisfactory, the client might attempt other stress reduction techniques such as moderate aerobic exercise. It is not suggested that a person persist at a task he or she finds undesirable.

In this study, subject's preferences were not taken into account. Thus, adherence of the yoga group was expected to be poor due to random selection of subjects who may have initially wished to participate in 10 weeks of moderate aerobic exercise. The aerobic group met only

once a week. Adherence was poorest in the yoga group,
averaging 75% between pre and post-intervention as
compared to 94% in exercise, placebo and control
conditions. Although the yoga dropout level compares
favourably with previous studies (Berger and Owen, 1988),
it can probably be attributed to the requirement of
individuals in this group to practise at home which was
not required of subjects in the exercise condition.
Similarly, however, the participants in the moderate
aerobic exercise group may have initially wished to
participate in the more passive Satyanda yoga classes.
In fact, however, the exercise adherence rate can be
regarded as excellent, as it has been argued that 80-85%
is the maximum adherence rate to be expected for
structured exercise programs, even in populations with
good facilities and favourable attitudes to exercise
(Martin and Dubbert, 1984). Overall the placebo and
control groups appeared to maintain adequate adherence
while the exercise group appeared to practise, as
requested, more consistently than the Satyanda yoga
group.

Overall, if assessing cognitive stress responses in
isolation it would appear moderate aerobic exercise is
more stress reducing than Satyanda yoga. Participation
in 10 weeks of moderate aerobic exercise decreases long-
term stress measures of tension as well as short-term
confusion responses to acute stress. In contrast 10
weeks of Satyanda yoga increases anger responses to acute

stress. However, stress is a unidimensional phenomena, and when examining its effects upon the body other measures such as somatic stress responses need to be assessed simultaneously.

## Physiological Changes in Response to the Intervention

It was hypothesized that 10 weeks of moderate aerobic exercise, as opposed to Satyanda yoga and placebo conditions, would increase the subjects' aerobic fitness. This in turn, would decrease their cardiovascular responses to acute stress. Because preceding studies had utilised primarily correlational designs (e.g., Holmes & Roth, 1985), the present investigation employed a methodology in which the same measurements were taken in every individual before and after a moderate aerobic training program. It was shown that in persons classified to be of below average fitness, exercise induced significant increases in their cardiovascular fitness and decreased levels of heart rate and diastolic blood pressure. HR and systolic blood pressure was not significantly altered in response to acute psychological stress.

Absolute heart rate data also suggested that subjects who engaged in aerobic exercise were significantly less physiologically aroused at recovery after experiencing the 10 week aerobic exercise program

as compared to the yoga and placebo groups. As expected, no significant difference in absolute heart rate was recorded between the exercise and no stress (control) group. Consequently, adjusted heart rate and absolute blood pressure measures did not conform with the forecasted decrement in cardiovascular reactivity to acute psychological stress in the moderate aerobic exercise group, as compared to the yoga and placebo groups.

Previous research has both refuted and supported these findings. The investigations which have recorded significant differences in cardiovascular responses during the administration of acute stress in subjects of varying levels of cardiovascular fitness have consisted primarily of correlational designs (Holmes and Roth, 1985; Hull, 1984; Light et al., 1987; van Doornen and de Geus, 1989). Consequently, from these studies it is not possible to conclude that superior aerobic fitness caused the stress response differences. Rather, as was used in the present investigation, a methodology is required in which responses to an acute stressor are taken in every individual before and after a moderate aerobic training program. Utilising these longitudinal designs, heart rate (Holmes and McGilley, 1987; Holmes and Roth, 1988), heart rate recovery (Sinyor et al., 1986), and diastolic blood pressure responses to stress (Sinyor et al., 1986; Sherwood et al., 1988) have been found to be reduced by increases in cardiovascular fitness.

Two investigators have found low fit subjects who participate in 10 to 12 weeks of aerobic exercise can increase their cardiovascular fitness and consequently decrease their adjusted heart rate (stress response-baseline) responses to acute stress (Holmes and McKinley, 1987; Holmes and Roth, 1988). One further longitudinal investigation found exercise training was only effective for enhancing the recovery from stress, rather than reducing the response to stress (Sinyor et al., 1986). Holmes and Roth, (1988) conclude that aerobic exercise training does not decrease the subjects' responses to stress, but instead reduces subjects resting heart rate and that reduction is carried forward to the stress period. Nonetheless, Holmes and Roth (1988) utilising adjusted heart rates did not totally eliminate the increased cardiovascular effect on extenuating heart rate responses to acute stress. Such was the case, however, in the present investigation where adjusted heart rates were not significantly effected by exercise training at any period throughout the stress trials. In contrast, after exercise training absolute heart rates were significantly lower at baseline, displayed trends of lower responses throughout stress, and were significantly different at recovery from the placebo and yoga groups who received the stressor. Blood pressure responses were not as consistent.

Previously, the one investigation that related exercise with reduced blood pressure, Sherwood et al. (1989) reported that exercise precipitated attenuation of blood pressure in subjects who were classified as borderline hypertensive. These subjects exhibited a substantial reduction in diastolic blood pressure following a three month training program, which also significantly increased subjects' cardiovascular fitness. Furthermore, an increase in diastolic blood pressure during and following the stressful criterion task were significantly reduced in borderline hypertensives who underwent aerobic exercise training, but not in those individuals who underwent strength training. Only one other correlational investigation has shown attenuated diastolic blood pressure responses to acute stress in high fit persons, also only in older and/or hypertensive subjects. Normotensive subjects in the present investigation decreased their resting diastolic blood pressure after exercise.

One unique finding in the present study was evidence of low blood pressure by all participants prior to the study. The range of pre intervention, group mean systolic blood pressure (102.50 (8.91) - 109.37 (13.55) mmHg) and diastolic blood pressure (59.67 (9.53) - 73.00 (12.34) mmHg), are both below the accepted community mean blood pressure of 120/80mmHg (Astrand, 1986). The implications of these recordings would suggest that the exercise and yoga group may have initially been mildly

hypertensive subjects. However, most comparisons of physically trained or occupationally active populations with untrained or inactive groups, as utilised in this study, show no differences in resting blood pressure (Fox and Mathews, 1981).

In contrast, these low resting blood pressures may have represented an abnormal hypotensive population sample. This would be consistent with the more relaxed Type B behaviour characteristics exhibited by the subjects in this study. The implications of the decrease in baseline diastolic blood pressure found among the present participants would suggest that normotensive or slightly hypotensive populations may also reduce their diastolic blood pressure with aerobic exercise and Satyanda yoga. Previously, exercise programs have reduced resting blood pressure by only a few millimetres of mercury in normotensives and up to 10mmHg in hypertensives (Seals and Hagberg, 1984). Nonetheless, the present investigation failed to find significant decreases in blood pressure responses to an acute psychological stressor after exercise training.

Several factors have been attributed to the lack of significant differences between low fit and high fit subjects on physiological stress reactivity measures in the present study. One of these contributory factors may have been a "ceiling effect". Sinyor et al. (1986) have noted that since subjects may be responding maximally to

highly stressful psychological laboratory tasks, differences in the response to exercise training may be obscured. The stressor in the present investigation was relatively mild in intensity as shown, that merely completing the motor task (control group) elicited heart rate and diastolic blood pressures to a similar extent as competing with a confederate and receiving bogus negative feedback (the acute stressor) while performing the criterion motor task. Holmes and Roth (1985) suggest that subjects in their investigation who were responding to a mild stressor recovered quickly. Therefore, differences among groups during the recovery period may have been precluded by a floor effect. The authors speculate the level of aerobic fitness may influence the response to stress, but the level of perceived stress will influence when the difference in cardiovascular responses will occur. However in the present investigation significant differences were recorded in absolute heart rate at recovery, in response to only a mild stressor and as such the findings tend to dispute this hypothesis.

Other factors have been discussed to explain the lack of significant differences in cardiovascular reactivity to acute stress between groups differing in aerobic fitness. The assessment of reactivity at the conclusion of the stressor, as opposed to measurement during the stressor period was not a consideration in the present investigation. Heart rate was assessed throughout

the stressor as well as at recovery. Sinyor et al. (1986) suggests 10 to 12 weeks of aerobic exercise may not be long enough to improve cardiovascular fitness such that stress responsitivity is altered. Cardiovascular fitness may have to exceed extreme levels to precipitate attenuated cardiovascular responses to acute stress. The reduced heart rate reactivity with aerobic fitness development recorded by Holmes and McGilley (1987), was achieved with a relatively short 13 week training period with low fit subjects and would consequently negate these arguments.

The type of exercise has recently been suggested as a contributory factor to reductions in cardiovascular reactivity to acute stress. Fredrikson (1989; cited in Kelson 1989), for example, found greater reductions in stress responses were obtained from aerobic exercise programs than from strength and flexibility training. Sherwood et al. (1989) in their assessment of potential mechanisms in the relationship between cardiovascular fitness and stress reactivity, have questioned the simplicity of the hypothesized modification of central autonomic balance toward reduced sympathetic and increased parasympathetic influences. These authors suggest the generally accepted peripheral systemic contributions to training-induced adaptations in aerobic fitness, may also contribute to decreased cardiovascular reactivity to mental stress in persons of superior fitness.

According to Sherwood et al. (1989), there is well documented evidence that improved maximal aerobic capacity as well as altered cardiovascular responses to exercise are specific to the type of exercising training utilised to produce the changes. The effects are related to peripheral adaptations of the vascular and enzymatic processes in the aerobically trained skeletal muscle (Astrand and Rodahl, 1986). Sherwood et al. (1989) speculate that altered reactivity during mental stress might occur only if the hemodynamic response pattern to the acute stressor includes the trained peripheral system.

The circuit training program which increased the aerobic fitness of the exercisers in the present investigation included a range of weight equipment (e.g., bench press, shoulder press) and aerobic (e.g., skipping and cycling) exercises. As such, the predominantly upper body motor requirements to complete the pursuit rotor task may have involved peripheral systems which were not significantly developed by the training program.

Van Doornen and de Geus (1989) have recently found the variables discriminating best on cardiovascular stress responses between high and low fit persons are pre-ejection period and total peripheral resistance. A correlational design was utilised in the van Doornen and de Geus (1989) study which limits the confidence of a causal link between increased aerobic fitness and

decreased stress responsitivity. Nonetheless, it appears that utilising heart rate and blood pressure recordings alone without peripheral cardiovascular measurements is inappropriate for fully understanding the relationship between aerobic fitness and cardiovascular reactivity. Peripheral changes would not appear as adequate an explanation for the results attributed to participation in the Satyanda yoga program.

The finding that 10 weeks of Satyanda yoga practise decreased resting diastolic blood pressure in normotensive subjects verified data obtained by other researchers on hypertensives (Patel and North, 1975). The unpredicted decrease in resting diastolic blood pressure of 17.4mmHg in the yoga subjects post intervention, compared favourably with the 15mmHg reduction previously attributed to yoga (Patel and North, 1975). A lack of reductions in resting heart rate and systolic blood pressure measures were in contrast to the results of previous investigations (Kalayil, 1988; Patel and North, 1975). As predicted, the 10 week yoga treatment did not reduce cardiovascular responses to acute psychological stress, or heart rate recovery responses. Previously, only one other investigation had assessed a passive stress management program's effectiveness in reduction of cardiovascular reactivity to acute psychological stress. Holmes and Roth (1988) found progressive muscular relaxation did not effect somatic acute stress responses.

Significant decreases in resting diastolic blood pressure were found in the Satyanda yoga group, even though the group experienced reduced frequency of practise per week. Previously, the length of time practising a meditative technique has been shown to account for 80 percent of variance in meditative success at decreasing resting levels of blood pressure (Kuchera, 1987). In fact, these results represent one of the only documented reductions in blood pressure in normotensive persons and then with a minimum amount of practice (four x 30 minute sessions per week).

The abnormally hypotensive characteristic of the subjects in the present study, becomes relevant when considering the implications of these reductions for hypertensive populations. For example, Johnston (1989) has reported that the use of stress management programs has been directed primarily towards the mildly hypertensive. It appears stress management induced reductions in blood pressure may occur in normotensive subjects and as such preventing normotensives from developing hypertension at a later date. Such a preventative orientation appears warranted with the expense hypertension represents to contemporary society (Roberts, 1982).

Obrist (1976) has proposed a model that implicates the sympathetic nervous system in the pathological process by which behavioural influences may contribute to

hypertension. According to this model, individuals who repeatedly exhibit pronounced sympathetically mediated arousal of the cardiovascular system, in association with their responses during psychological stress, may be at particular risk for the development of hypertension and cardiovascular disease. Accordingly, the decreased resting diastolic blood pressure of the yoga subjects in this study may be connected with the findings of increased anger by this group in response to acute stress.

Julius, Harburg, Cottington and Johnson (1986) in a comparison of subject responses to various anger provoking scenarios found those who inhibited anger or experienced guilt about its expression were much more likely to die (due to various causes) during the subsequent 12 years than those who expressed their anger. Wright and Sweeney (1989) have found that those subjects experiencing higher resting diastolic blood pressure were more likely to cope with acute stress using strategies characterisized by wishful thinking, avoidance and minimization of threat.

Mills, Schnieder and Dimsdale (1989) also found anger expressed outwardly to be related to lower heart rate responses to stress. These authors noted that heart rate reactivity may be a potential risk factor for high blood pressure and cardiovascular disease. If so, the outward expression of anger and the consequent

reduced reactivity to the stressor may mediate the processes associated with lower blood pressure and reduced incidence of cardiovascular disease. The yoga subjects in the present investigation may have reduced their resting diastolic blood pressures through outward expression of their anger to acute stress.

It would appear then, that yoga with its consequent outward expression of anger coupled with the elicitation of the Relaxation Response (Saraswati, 1984) and exercise with its decrease in absolute heart rate reactivity, may result in decreased resting diastolic blood pressure and decreased incidence of hypertension and cardiovascular disease.

## Type A Behaviour and Stress Reactivity

According to Light et al. (1987), other issues that need to be addressed concerning the effects of exercise and yoga upon stress reactivity are whether aerobic exercise training is also associated with alterations in behavioural characteristics, and whether such characteristics may be useful predictors of persons most likely to benefit from an aerobic physical training program. One approach to addressing this issue in the present study was the relationship of Type A and B behaviour upon stress reactivity.

The subjects' overall Type A scores as well as their Irritable and Impatient subscores, both derived from the student version of the Jenkins Activity Survey were assessed in this study. The Irritable and Impatient subscore was positively related with greater cardiovascular reactivity to psychological stress (Öhman et al., 1989).

Initially, the subjects' characteristics classified the groups as having the Type B behaviour pattern. They scored low in Impatience (i.e., below the arbitrary score of 21 as derived by Öhman et al., 1989). The present investigation found moderate aerobic exercise and the Satyanda yoga programs did not significantly affect either score. It would appear that significant changes from these initial behavioural characteristics would have indicated a transition towards a more stressful disposition (i.e. the Type A behaviour pattern) or perhaps, conversely, to levels of inactivity, commensurate with the stress-inducing effects of boredom. Consequently, the lack of change in Type A/B disposition represented the preferable outcome in terms of stress reduction. It appears 10 weeks of either exercise or yoga fails to alter Type B behaviour characteristics.

## Stress and Motor Learning

The inclusion of learning measures was also examined in this study for interpreting the relationship between cardiovascular fitness and overall stress reactivity.

Research dealing with the effects of aerobic fitness on stress reactivity, as measured by motoric variables, has largely been concerned with dependent variables relating to motor performance as opposed to learning (Light et al., 1987; Sothmann et al., 1987). Aerobic endurance, as it effects motor learning in response to acute stress, has evidently not been examined.

A review of the pertinent literature revealed that learning will improve if arousal is intensified following acute stress (Marteniuk and Wenger, 1970; Sage and Bennett, 1973). One rationale for this contention can be Consolidation Theory (Walker and Tarte, 1963). The authors postulated that the neural memory trace established by practice will be more "robust" under high arousal and, since this neural trace is essential for the production of a structural modification in the nervous system (represented by long-term memory) higher arousal during the practice period will facilitate long-term memory. Learning, in the present investigation, occurred prior to the initiation of the treatment and then again 10 weeks later at post-testing.

Prior to the intervention, all groups except the control group received the stressor. Physiological response variables indicated the groups receiving the stressor had higher systolic blood pressure (placebo and yoga) and diastolic blood pressure (placebo and exercise) than the control group. However, the groups did not differ according to their heart rate reactions to completing their respective group requirements. Motor

performance measures indicated that groups did not differ throughout pre intervention testing. It appears the competition and consequent bogus negative feedback were not sufficiently more arousing than merely completing the motor task.

Post intervention learning scores displayed tendencies to be influenced by the acute stressor as predicted. The placebo group revealed insignificant tendencies towards greater learning while reacting with statistically greater arousal to the mental stressor. As previously assessed, absolute heart rate and diastolic blood pressure resting levels were attenuated in the exercise group at post intervention, similar reductions occuring throughout the trials. Resting diastolic blood pressure was also reduced in the yoga group. No cardiovascular changes were recorded for the placebo group at rest, or throughout administration of the acute stressor, post intervention. The control group did not receive the mental stressor and were found not to be as aroused as the three other groups, as determined by systolic blood pressure. Consequently, the placebo group which had the highest arousal in response to acute stress exhibited insignificant trends towards greater learning scores in contrast to the control and exercise groups at post intervention.

## CHAPTER VI

## CONCLUSIONS AND FUTURE RESEARCH

## Conclusions

Generalizations derived from the present investigation must be restricted in terms of the inherent limitations of stress management research. This includes the multidimensional nature of stress with at least cognitive, behavioural, physiological and motoric consequences, as well as stress influences varying according to the duration of time stress management techniques are utilised. Within the confines and limitations of the study, the following conclusions are warranted.

Moderate aerobic exercise results in long-term cognitive stress reduction, in persons classified as Type B and of below average fitness. This was evident on the tension subscale of the POMS. Given the limitations noted of the yoga treatment group, subjects in the Satyanda yoga treatment group did not report any long term cognitive stress reduction. A decrease in long-term stress, as determined by a pyscological scale, does not precipitate desirable short-term responses to an acute mental stressor. Nonetheless, exercise decreases short-term confusion, whereas Satyanda yoga increases short-term anger to an acute stressor.

Resting diastolic blood pressures were reduced after a 10 week program of moderate aerobic exercise as well as a Satyanda yoga program of similar duration. These reductions eventuated in a population of slightly hypotensive Type B's and extend previous contentions of stress management induced diastolic blood pressure decreases in hypertensive groups only. The exercise program also significantly decreased resting heart rate. Rather than reducing the subjects' responses to stress, aerobic exercise participants reduce their resting heart rate which in turn promotes recovery from stress. Reductions in heart rate, then, are considered to be the result of a significant increase in cardiovascular fitness. Finally, improved aerobic fitness appears to elicit lower absolute arousal. Short-term cognitive stress responses may influence long-term physiological stress response variables. It appears that long-term and short-term cognitive and somatic responses to stress may be interrelated.

## Future Research

Further research is needed to determine how the reduction in long-term cognitive stress occurs as a function of moderate aerobic exercise, and the role of tension as an indicator or predictor of long-term stress alteration. Furthermore, investigations which incorporate both cognitive and physiological dependent variables permit a more in-depth examination of the potential mechanisms of cognitive changes. For example, the increased short-term anger responses to acute stress

in the Satyanda yoga subjects may be linked to the decreased baseline levels of diastolic blood pressure recorded by these subjects.

Assessment of the mechanisms which resulted in decreased resting diastolic blood pressure in slightly hypotensives from both an active, and a passive stress management technique has implications for the multidimensional nature of the influences which precipitate the development of hypertension. Exercise induced reductions in diastolic blood pressure appear to be a function of some form of cardiovascular development, whereas the decrease in the yoga subject's blood pressure may have been in response to the expression of anger. Comprehensive assessment of stress appears to require multidimensional longitudinal measurement.

Further research investigating the effects of exercise on cardiovascular responses during sudden, environmentally-induced stress are clearly needed to fully understand the mechanism by which aerobic exercise may reduce the stress response. Further, stress responsivity needs to be assessed by cardiovascular variables other than merely heart rate and blood pressure. Such precise measurement may detect peripheral alterations to help clarify which form of exercise training is most effective for improving a person's ability to cope with stress.

Investigations should also assess the possible benefits of exercise or stress responses in other specific populations. For example, further research is warranted to investigate whether persons scoring high on the irritable and impatient subcomponent of the Type A behaviour pattern can significantly reduce their scores after participating in a moderate aerobic exercise program. Consequently, in combination with superior aerobic fitness there is a need to determine if reduced impatience would attenuate heart rate or blood pressure responses during recovery from psychological stress.

Finally, the influence of improved cardiovascular fitness upon reduction in acute stress arousal and consequent motor learning requires further assessment. Future studies should measure arousal with greater precision in addition to heart rate and blood pressure to ascertain the effect of cardiovascular fitness on motor skill learning. Based on the results of this study and those of previous investigations, the potential benefits of aerobic exercise on the mental and physical well-being of the individual has significant implications for coping with stress and maintaining a high degree of life satisfactions.

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## APPENDIX A

## INFORMED CONSENT

The University of Wollongong's Human Movement Department is currently investigating the efficiency of alternative methods of exercising. Several methods have previously been shown to be effective including; progressive relaxation, yoga and aerobic exercise. To determine which is most effective, upon completion of the Jenkins Activity Survey, I will be asked to complete a simple motor task in a competitive situation. A ten week program will then instruct me in alternative methods of exercising.

As a subject it will be necessary to complete two submaximal assessments of my aerobic fitness. The exercise test will begin at a level easily accomplished by me and will be advanced in stages depending on my fitness level. Personnel may stop the test at any time because of signs of fatigue or I may stop when I wish due to personal feelings of fatigue or discomfort.

The progressive workload protocol minimizes the chance of causing unusual blood pressure changes, of fainting, disorder of heart beat and in rare instances, heart attack or death. All personnel are trained in first aid and how to deal with such extreme cases if they should ever occur.

All information which is obtained will be treated as privileged and confidential and will not be released or revealed to any person without my expressed written consent. As a volunteer for this study I understand that I have the freedom to discontinue participation of the study at any stage.

I have read the above and agree to participate in this research project. Any questions that I have concerning procedures or the project in general have been answered to my satisfaction.

DATED this                    day of                    1989


SIGNATURE     .........................

WITNESS       .........................

# APPENDIX B

## DESCRIPTION OF THE STUDY

I am a post graduate student in the Human Movement Department at the University of Wollongong. I am interested to see the effects aerobic fitness has upon the stress response and consequent motor performance. As such I have recorded your aerobic fitness level and I am now interested to record your motor performance. More specific instructions will follow after you "rest" for three minutes.

# APPENDIX C

## INSTRUCTIONS FOR ACUTE STRESS ADMINISTRATION

You are about to undergo a test of your fine motor skills. You are to use a pursuit rotor apparatus. You have to try to keep a wand on the rotating light for as long as you can. You will be required to follow a cycle whereby you work for 20 seconds and then rest for 20 seconds. Initially five trials will be timed. There will be a short rest period where your blood pressure will be taken followed by another five trials. You will be competing with one another and will receive immediate feedback as to your performance results. No practise session will be allowed.

## APPENDIX D

## WIN/LOSS RATIO

1. "Subject's name", you lost!
2. "Subject's name", you lost again!
3. "Confederate's name", you lost that one.
4. "Subject's name", that was poor!
5. "Subject's name", you've lost yet again, that means you have lost four, "confederate's name" one.

Immediately prior to initiating trial six;

Now I ask that "subject's name", you especially concentrate to try and perform better during the next five trials. Your score is very important and at the moment you are losing.

6. "Subject's name", you've lost again!
7. "Confederate's name", you lost that one.
8. "Subject's name", that was poor!
9. "Subject's name", you lost that one, "confederate's name" was too good for you again.
10. "Subject's name", you lost.

Immediately after concluding scoring Trial 10;

...that indicates that you lost eight out of ten trials "subject's name". Therefore, you have performed poorly.

## APPENDIX E

### ART APPRECIATION PERFORMANCE PROGRAM

## The School of Creative Arts

*presents*

# THE ART OF LUNCH

Thursdays 12.35 - 1.25 pm during Session
Music Auditorium, School of Creative Arts, University of Wollongong

### PROGRAMME OF EVENTS
### Session Two 1989

20 *July 1988*

MUSICA TROppO (David Piper - 'cello, Nicole St.Ilan - viola, Andrew Schultz - clarinet, David Vance - piano) play trios by Mozart and Beethoven and a new arrangement of Stravinsky's *Tango* .

27 *JULY*

Composer DAVID LUMSDAINE is Artist in Residence at Wollongong University and is joined by leading UK composer NICOLA LE FANU for an open conversation featuring excerpts from their recent work.

3 *AUGUST*

PERIHELION, the permanent ensemble at Queensland University, are currently in residence at the School of Creative Arts; their concert will feature Robert Davidson's *Tapestry* plus music by Stucky and Bruch.

10 *AUGUST*

Final year writing and directing student CAMPION DECENT presents A Very Wasp of Flowers.

17 *AUGUST*

BAG PROJECT: Dutch sculptor and performance artist JOSE AERTS is Artist in Residence at the University of Wollongong and presents the first of two performances.

24 *AUGUST*

THE SERAPHIM TRIO: Floyd Williams, lecturer in clarinet at Queensland Conservatorium, is joined in a recital by faculty from the University of Cincinnati, Patricia Berlin (mezzo-soprano) and Donna Loewy (piano) in Alison Bauld's *Banquo's Buried* plus works by Horvit, Brahms and Spohr.

31 *AUGUST*

Caribbean poet, Professor EDDIE BAUGH, is a visitor to the English Department. He will read from his recent work.

7 *SEPTEMBER*

HARTMUT LINDEMANN, viola tutor at Wollongong University and former Principal Viola, Sydney Symphony Orchestra, is joined by Sandra Kuo (piano) in works by Milhaud, Ravel, Debussy and others.

14 *SEPTEMBER*

Leading jazz guitarist MICHAEL PRICE, who recently returned from America, joins with bass player Craig Scott, of the Don Burrows Quartet, for a program of jazz with a contemporary twist.

21 *SEPTEMBER*

GEOFFREY BURGESS, Australia's foremost Baroque oboist gives a recital of 18th and 20th century music featuring Benjamin Thorn's *Segallic* and *Three Pieces* by John Exton plus works by Bach and Telemann.

12 *OCTOBER*

Newly appointed lecturer in creative writing at the School of Creative Arts JOHN SCOTT reads from recent work including his collection *Singles* (UQP).

19 *OCTOBER*

An Artist Two Months Later: Dutch performance artist JOSE AERTS recovers (in public) from her residency at the School of Creative Arts.

26 *OCTOBER*

Master of Creative Arts student BERGRID FERREIRA (piano) presents Sea-Change by Andrew Schultz plus works by Beethoven and Liszt in her final recital.

2 *NOVEMBER*

Just when you thought it was safe ... SHORT BACK AND SIDES return, by popular demand, with more iconoclastic cabaret.

*Enquiries:* 042-270987 or 042-270996     *Admission:* free
*Parking:* enter by Western Entrance, Northfields Avenue.     *Convenor:* Andrew Schultz