STRESS, ATTENTION, AND SPORTS INJURY

SUBMITTED TO SATISFY THE REQUIREMENT FOR THE

DOCTOR OF PHILOSOPHY DEGREE BY RESEARCH

BY DAEJIN BUM

DEPARTMENT OF HUMAN MOVEMENT,

RECREATION AND PERFORMANCE

FACULTY OF HUMAN DEVELOPMENT

VICTORIA UNIVERSITY OF TECHNOLOGY

FEBRUARY, 1998

Abstract

This thesis investigated part of the Andersen and Williams (1988) model of stress and injury. Three studies were carried out. The first study examined the relationship between life stress and athletic injury. The sample consisted of 320 (234 males, 86 females) competitive contact team sport athletes in Melbourne clubs, who completed the Athletic Life Experience Survey (ALES) and Injury Surveillance System (ISS) to assess the stress-injury relationship. Injured athletes had higher ALES negative scores than athletes who were not injured (F (1, 316) = 7.28, $p <$ .007). Further, higher levels of negative life stress were found for injuries where three to nine days were missed than for injuries where there was no missed practice and competition (F (3, 312) = 4.74, $p <$ .003). The second study examined the effect of stress and psychosocial factors on visual attention. Twenty physical education students (10 male, 10 female) performed central and peripheral visual attention tasks under four stress conditions in a Latin Square design. Prior to performing the task, participants completed the ALES, Athletic Coping Skills Inventory (ACSI), and Social Support Questionnaire (SSQ-6) to measure psychosocial factors and a test of physical work capacity (PWC). Participants then performed the visual tasks (a) in a noise (white noise) condition, (b) in a physical activity condition, (c) with both noise and physical activity, and (d) in a baseline condition, with no noise or physical activity. Results indicated that participants in the stress conditions had significantly greater errors in detection of signals from a central (F (3, 76) = 2.88, $p <$ .05) and peripheral targets (F (3, 57) = 17.44, $p <$ .001). Participants also had significantly

supported Study 2, with decrements in central (F (2, 69) = 25.51, p < .001) and peripheral (F (2, 46) = 148.94, p < .001) task performance under physical and physical plus psychological (noise) stress, which increased for larger peripheral angles. A significant (p < .05) reduction in A-state from pre- to post-intervention indicated significant (p < .05) in central and peripheral response times in the physical activity and physical activity/noise conditions for the AT group compared to the control group. Again, these reductions in response time were greater at wider peripheral angles. It was concluded that the results of the present thesis provide strong support for aspects of the Andersen and Williams (1988) model of stress and athletic injury relating to the effect of stress on attention and the influence of appropriate interventions to reduce stress.

Acknowledgments

I would very much like to thank my supervisor, Dr. Tony Morris, for his diligent support and professional guidance throughout the study. Without his encouragement and the enormous amount of patience, this thesis would not have been completed. I would also like to thank my co-supervisor, Dr. Mark Andersen, for his advice and valuable suggestions in helping me develop this thesis. I would very much like to note the support of Ian Fairweather, Laboratory Manager, for his kindness and for making my research equipment. I would also like to thank Mark Stoove for his proof reading and help with the language. My appreciation goes to the VUT physical education and recreation students who agreed to take part in the study. I would also like to thank the coaches and athletes of the Victorian hockey, football, taekwando, lacrosse, judo, and soccer teams, for their cooperation.

I would like to thank my parents, Jungkyoon Bhum and Soonja Yoo, for patiently waiting for my study to be completed. Without their enormous support, this thesis would not have been possible. Thanks also go to my sister, brother-in-law, and John, whose help has made life in Australia much easier.

Table of Contents

Appendices

List of Tables

List of Figures

Chapter 1: Introduction

The increase in popularity of sports and recreation has resulted in an increase in athletic related injuries. For example, Smith (1996) reported that of eight million students who participate in high school sports and recreation in the United States each year, two million incur injury. Even with technological advances in athletic equipment, medical support, physical conditioning, and coaching techniques, the incidence of sports injuries still continues to rise (Hanson, McCullagh, & Tonymon, 1992). Although physical and environment factors such as condition of the athletes and field, design of equipment, and playing time are among the causes of athletic injury, it has been hypothesised that psychological factors play an important role as well. During the last 20 years, psychological aspects of stress such as the effects of life stress, anxiety, daily hassles, and social support on injury outcome has become an increasingly important area of study in sport psychology, because a high level of stress can lead to accidents, injuries, and poor performance in athletes (Heil, 1993).

In 1988, Andersen and Williams presented a model of stress and athletic injury that offers various predictor variables of athletic injury, examines possible mechanisms underlying the stress-injury relationship, and suggests specific interventions for reducing the risk of athletic injury. Andersen and Williams (1988) proposed that a person's history of stressors (e.g., life events, daily hassles), personality (e.g., competitive trait anxiety, hardiness, locus of control), and coping resources (e.g., stress management, social support, mental skills) may have an influence on the magnitude of the stress response when an athlete is in a stressful situation. Andersen and Williams

(1988) suggested that an elevated stress response in athletic situations, and particularly, the accompanying muscle tension and attentional disruptions (narrowing of the visual field and increased distractibility), increase the risk of athletic injury. They hypothesised that individuals with a history of many stressors, personality traits that exacerbate stress responses, and low coping resources, when placed in stressful situations, may experience a larger stress response, reflected in greater peripheral narrowing and increased distractibility, as well as high levels of muscle tension. In their model, Andersen and Williams also proposed various interventions that would be predicted to affect either tension or attention or both, leading to a reduction in the effect of stress on injury incidence. These interventions are divided into two groups; those designed to alter cognitive appraisals, such as cognitive restructuring, thought stoppage, and confidence training, and those designed to alter the attentional/physiological aspects of the stress response, such as relaxation techniques, autogenic training, imagery, meditation, and medication modification.

The main aim of this research was to test part of the Andersen and Williams model (1988) of stress and athletic injury. The first study in this thesis investigated the relationship of life stress to athletic injury, and the number of missed days due to injury. The second study examined central and peripheral attentional processing during situations with different levels of objective physical and psychological stress, for individuals with varying levels of life-event stress, coping skills, and social support. Specifically, the study aimed to examine the effects of stress on visual attention within a laboratory setting. The third study conducted another test of the effects of stress on central and peripheral visual attention, under similar conditions to study two, and then investigated the effectiveness of an anxiety management program for reducing the anxiety response to a stressful situation and the effect of the program on visual attention under stress.

Chapter 2: Literature Review

Introduction

In this chapter, sports injury, including incidence and severity, as well as the relationship between psychological factors and sports injury, is described. Models of stress and injury are considered and a model of stress and injury proposed by Andersen and Williams (1988) is then described. This is followed by a critique of the measures primarily used in stress-injury research and a discussion of research in the areas of psychosocial antecedents of athletic injury, mechanisms underlying stress, such as physiological/attentional changes, and the efficacy of interventions to reduce the effects of stress on the incidence of injury. The chapter concludes by indicating the theme of the present thesis, based on the foregoing review.

Sports Injury

Injury is a major problem in sport. In spite of advances in training methods, medical care, equipment, coaching, and physical conditioning, the injury rate does not appear to be declining significantly (Crossman, 1997). Many injuries may be caused due to low fitness or by situational factors including equipment, type of sport, and environmental conditions (Seward & Patrick, 1992). According to a study by Kerr and Cairns (1988), perceived physical fatigue is the most common cause of injury. There has been growing evidence of the possible impact of psychological factors on injury occurence. In a study by Kerr and Minden (1988), the majority of elite gymnasts reported 'lack of concentration' or 'thinking of other things' as the major cause of injury. Also, Andersen and Williams (1988) reported that an elevated stress response in athletic situations, and particularly, the accompanying muscle tension and attentional disruptions, increase the risk of sports injury.

Factors Related to the Incidence of Sports Injury

A sports injury is defined as a situation where the player has perceived that bodily harm has been sustained during sporting activities or that the player displays obvious disability, necessitating that the person stops playing (Garrick & Requa, 1978). A number of other definitions of a sports injury have been used in the literature such as, any sports injury treated at a hospital, any physical damage caused by a sports-related incident whether or not it results in any incapacity to the participant, time lost from sport, or an injury claim on sports insurance (Barker, Beynnon, & Renstrom, 1997; Brock & Strowski, 1986; Cunningham & Cunningham, 1996).

Injuries may be classified according to their causes. May and Sieb (1987) have divided injury causes into several categories: (a) sport specific factors (e.g., type of sport, equipment); (b) participant factors (e.g., psychological status of the athlete, experience, age, gender, physical conditioning); (c) environmental factors (e.g., weather, playing surface); (d) coaching factors (e.g., quality, type, extent); and (e) consequences of chance. A sport specific factor such as type of sport can increase the incidence of injury. Many researchers have reported that more injuries are sustained in contact team sports and combat sports than in noncontact sports (Cunningham & Cunningham, 1996; Inklaar, 1994; McKay, Payne, Goldie, Oakes, & Stanley, 1996; Seward & Patrick, 1992). In a study by Cunningham and Cunningham (1996), of the 5,106 athletes who participated in 19 sports at the 1994 Australian Universities Games, there were 1,177 injuries, sustained by 994 athletes, representing 19.5% of all participants. This study found that combat and contact sports had the highest incidence of injury, accounting for 51.4% of all injuries. Participant factors such as physical conditioning and psychological status, can influence injury outcome. Kerr and Minden (1988) reported that female gymnasts attributed 12% of their injuries to a lack of concentration or thinking of other things, 9% to fatigue, 7% to equipment, and 5% to repeat of a previous injury. Environmental factors such as weather and playing surfaces can increase injury risk (May & Sieb, 1987). If there is bad weather or a poor playing surface, there is an increased risk of injury, because there are more chances for mistakes to be made. Coaching techniques also influence injury. For example, if an athlete has been taught to play unfairly, there is greater risk of injury to the athlete and probably to other athletes. Finally, the possibility of injury occurring by chance is something every athlete faces whenever participating in sport activities. As long as an athlete competes in sports, there is always risk of injury.

The severity of the injuries sustained has often been defined by the duration of absence from competition and training. Williams, Tonymon, and Wadsworth (1986) classified the seriousness of injuries in accordance with the National Athletic Injury Reporting System (NAIRS). According to the NAIRS, a minor injury was classified as one where the injured player returned to play within one to seven days, moderate injury was nonparticipation for 8 and 21 days, and severe injury was defined as occurring when a player was sidelined for more than three weeks. Williams et al. (1986) investigated the severity of injury in a sample of 179 National Collegiate Athletic Association (NCAA) Division I volleyball players. They found that 72% of injuries were minor, 16% were moderate, and 12% were severe injuries. Petrie (1993a) also found that, for a group of 98 NCAA Division I-A football players, 52 (53%), 21 (20.4%), and 16 (16.3%) of the players suffered minor, moderate, and severe injuries, respectively. A difficulty with measurements of "severity" is that different research has defined severe, moderate, and minor injury at different levels or using alternative criteria. There is another problem in the measurement of injury severity. Not only does severity measurement ignore the impact, or meaning, that the injury has for the athletes, but also it does not take into account whether it was a small or big injury, in terms of the area of the body affected, that caused that severity of injury. An accurate measurement of injuries would seem to be important, if one wishes to investigate sports injuries. Numerical coding, or labeling of athletic injuries will not take into account the impact or meaning the injury has to the athlete. This method can only collect general injury information. Future injury research should measure injury outcome by the use of well-structured interviews, as well as self-report scales, to take into account the meaning of, and effect of, injury to the individual.

Psychological Factors and Sports Injury

Despite technological advances, such as improved athletic equipment, creation of safer playing conditions, education of players and coaches in observance of safety rules and safe playing behavior, advanced teaching and coaching techniques, development of scientific conditioning programs, and the certification of trainers for sports programs, athletic injuries have continued to rise in most sports (Bond, Miller, & Chrisfield, 1988; Heil, 1993). Physical and environmental factors do not adequately explain athletic injury variance. Therefore, examination of other factors contributing to sports injuries seems warranted.

Moore (1960) was one of the first researchers to study psychological factors and injury. Moore found that young athletes who were under or over aggressive developed "magical thinking", where they believed they could not get hurt. This, in turn, may lead to athletes taking unnecessary, dangerous risks that in time would result in injury. Sanderson (1977) described several psychological factors that may predispose individuals to injury during athletic performance. He stated that "competing in sport or the expectation of competing, by the inner conflict it creates, can induce high levels of stress in athletes" (p. 56).

During the last 20 years, the effects of psychological factors, such as life stress, anxiety, daily hassles, coping resources, and social support, on injury outcome, has become an increasingly important area of study in sport psychology (Andersen & Williams, 1988, 1993, 1997; Blackwell & McCullagh, 1990; Byrd, 1993; Coddington & Troxell, 1980; Cryan & Alles, 1983; Fawkner, 1995; Hanson, McCullagh, & Tonymon, 1992; Hardy & Riehl, 1988; Kerr & Minden, 1988; Passer & Seese, 1983; Petrie, 1992, 1993a, 1993b; Smith, 1996; Smith, Ptacek, & Smoll, 1992; Smith, Smoll, & Ptacek, 1990; Sanderson, 1977; Summers, Fawkner, & McMurray, 1993; Williams & Roepke, 1993; Williams, Tonymon, & Wadsworth, 1986). In a review, Williams and Andersen (in press) identified at least 30 studies that have examined the psychological factors that relate to sports injury. Among the 30 studies, 90% of the studies found a significant relationship between life stress and injury, and only 10% found no effect (Petrie & Stoever, 1994; Williams, Haggert, Tonymon, & Wadsworth, 1986; Williams et al., 1986). Approximately two-thirds of the studies found some relationship between psychological factors and severity of sports injury (Andersen & Williams, 1997;

Blackwell & McCullagh, 1990; Hardy & Riehl, 1988; Kerr & Minden, 1988; Passer & Seese, 1983; Petrie, 1992, 1993a) and one-third found no effect (Cryan & Alles, 1983; Hardy, Richman, & Rosenfeld, 1991; Lysens, Vanden Auweele, & Ostyn, 1986; Williams et al., 1986). The research on psychological factors and sports injuries will be discussed in more detail, in the context of the Andersen and Williams model later in this chapter. To understand the role of psychological factors in the incidence of sports injury, a good place to begin would be to discuss stress. High levels of stress in one's life have been consistently linked with sport injuries since the work of Holmes (1970).

Stress

Many accidents and injuries, not only in sport but also in the home, on the road, and in the workplace, can be related to the effects of stress. Major and minor stressful events can affect a person's physical, mental, and behavioural health, leading to increased heart rate, blood pressure, anxiety, depression, and attentional disruptions, for example (Selye, 1976). In order to understand how stress can adversely affect performance, it is important to discuss how stress is conceptualised, as well as clarifying how stress has been defined by researchers. It is also important to distinguish between the terms stress and anxiety, in order to establish the appropriate, standardised use of these terms in future research.

Definition of Stress and Anxiety

Stress. Stress can be described as a wide range of physiological and biochemical changes that take place in the body, either in acute or chronic conditions, that are induced by various psychological or physical factors or a combination of these factors, that are perceived by the organism as a threat (Mace & Carroll, 1989).

The phenomenon of biological stress was first noted in 1926 by Selye (1976). As a second year medical student at the University of Prague, he noted that individuals suffering from a wide range of physical illness seemed to have a pattern of common symptoms. These included loss of appetite, decreased muscular strength, elevated blood pressure, and loss of ambition to carry out anything (Selye, 1976). Wondering why these symptoms seemed to appear regardless of the nature of the somatic disorder led Selye to label this condition as the "syndrome of just being sick" (Selye, 1976). He further hypothesised that this syndrome was the result of the efforts of the body to adapt to changing conditions. He refined his "syndrome of just being sick" concept to the description of a phenomenon that he termed the "general adaptation syndrome" (GAS; Selye, 1976).

The GAS consisted of three stages encountered by an individual in stressful situations: alarm, resistance, and exhaustion. The alarm stage is the body's first reaction to stress. This stage is concerned with concentrating the body's defense mechanisms, either locally or encompassing entire organ systems, to combat the stressor. The stage of resistance is the time when the organism builds up a tolerance to a stressor. Selye suggested this stage occurs when the body has produced the most effective line of defense for combating the particular stressor. He believed that during this stage the body attempts to return to its normal state of equilibrium. The exhaustion stage is the period when the body can no longer adapt to the stresses imposed. This stage occurs when the body's capacity for resistance is completely exhausted, and the bodily reactions of the alarm stage reappear. If the body reaches this stage, tissue breakdown, and ultimately death will occur. With all of these concepts in mind, Selye (1976) built his formal definition of stress as "a non-specific response of the body to any demand placed upon it" (p. 113). He extended his definition of stress to describe both the subjectively positive aspects (eustress) and the subjectively negative aspects (distress). Eustress represents the challenge of life, the necessary adaptive demands that promote positive growth and health, whereas distress is excessive stress and the adaptive demands push the individual past optimal growth conditions to a pathogenic state capable of fostering disease.

Stress has also been viewed from a psychological perspective. Appley and Trumbull (1967) defined stress as "situations characterized as new, intense, rapidly changing, sudden or unexpected, including but not requiring approach to the upper threshold of tolerability" (p. 128). They also believed that an absence of stimuli can be stressful, as can stimuli that lead to cognitive misrepresentations, and hallucinations. Thus, Appley and Trumbull proposed the idea that stress is in the eye of the beholder. The above mentioned conceptualisations seem to indicate that stress does not have the same meaning for everyone. It also cannot be isolated to only a physical, psychological, or behavioral perspective, but rather as a combination of these.

Anxiety. Anxiety is perhaps one of the more common effects of stress. Anxiety is characterised as an emotional state consisting of subjective, consciously experienced feelings of tension, apprehension, nervousness, and worry (Speilberger, 1989). Martens (1977) suggested that anxiety occurs when an individual's perception of threat is greater than one's perceived ability to cope with that threat, while Gould & Krane (1992), described anxiety as "feeling of nervousness and tension associated with activation or arousal of the organism" (p.121).

Spielberger was primarily responsible for eliminating some of the ambiguity in anxiety theory in research by identifying two dimensions of anxiety, namely trait anxiety and state anxiety. State anxiety (A-state) refers to a transitory condition that varies in intensity and fluctuates over time. The level of intensity and duration of state anxiety is dependent on the number of stress stimuli acting on the individual, and the duration of the subjective feelings of threat caused by these stimuli. Trait anxiety is described as a relatively stable personality characteristic (Spielberger, 1972). It is relatively stable predisposition to perceive many situations as threatening and to respond to these situations with increased state anxiety. Spielberger (1972) found that persons who were high in trait anxiety reacted with high arousal and state anxiety when faced with stressful or threatening situations.

As noted, there is a clear distinction between the terms stress and anxiety. Stress can be presented as a process that involves the mediation between what a person perceives as threatening and the product of environmental stimuli. The current status of anxiety shows it to be a cognitive and somatic response to stressful circumstances, that can be distinguished in terms of situational anxiety (state anxiety), and anxiety as a personality trait (trait anxiety).

The Stress Process

To understand stress, it is important to discuss the stress process. Stress is described by McGrath (1970) as a process consisting of four stages. McGrath defined the first stage as the environmental situation, or the demand placed upon the individual.

The second stage is the individual's perception of the environmental situation. Within a sporting context, Martens (1977) described this stage in terms of an athlete feeling threatened, if they perceive the environmental situation as placing demands that are beyond their response capabilities. The third stage involves the response of the individual, which includes an increase in physiological arousal, and increases in negative and positive states. The fourth stage of the stress process is performance. This model of stress became the basis for a process-oriented definition of stress adopted by many sport psychologists (e.g., Gould, 1987; Gould & Petlichkoff, 1987; Martens, 1977; Passer, 1982).

According to Passer (1982), as illustrated in Figure 2.1, the stress process begins with a situation or sensory stimulus, often called the stressor. The stimulus can be produced from internal processes or it can be an external (environmental) event. Internal processes consist of a person's heredity, inner drive, motivation, and memory from past experience. External events include diet, climate, and season. The next step in the stress process is one's cognitive appraisal of the stressor and of one's ability to deal with this demand. The appraisal of a stressor leads to the specific responses to stress such as anxiety and arousal. Anxiety is one of the more prevalent effects of stress on a person's behaviour. Morgan and Ellickson (1989) stated that arousal is the body's heightened awareness that a stressor is present and its signal to the higher brain centre that there is a need for preparation to respond (physiological). Whether this appraisal is positive or negative influences the next stage in the stress process. The third stage deals with how one feels about what happened. Resulting from the cognitive appraisal is an emotional response or affective reaction to a stressor, such as anxiety, worry, anger, or frustration. This stage may also have an impact on one physically via the actual pain associated with the stressor, such as undesired contractions at the site of an injury (Nideffer, 1983). The final step in the stress process is the behavioural consequence of the physical and psychological responses. For example, the consequences of the physical and psychological responses could be chronic tension in the affected area, loss of appetite or sleep, and lack of motivation. Miller and Vaughn (1986) found that athletes with high levels of stress tended to have more difficulties in sleep patterns and noted a higher incidence of sleep disturbances than athletes with low levels of stress. Athletes with high levels of stress perceived that they had less control over their own lives and activities, including their athletic skill, than did athletes with low levels of stress. As a result, it appears that stress has both physiological and psychological components.

1. SITUATION	4. CONSEQUENCES
demands constraints opportunities	behavioral psychological health-related
↓	↑
2. APPRAISAL	3. EMOTIONAL RESPONSE
of situation and personal resources →	psychological and cognitive-attentional components

<u>Figure 2. 1.</u> The stress process (adapted from Passer, 1982)

The Stress Response

The somatic stress response to stimuli perceived as a threat is manifested in a very specific manner. The somatic stress response consists of a biochemically regulated set of physiological changes that control several organ systems and chemical reactions in the body. The physiological changes that occur as a result of the stress response are an effort by the organism to achieve physiological balance and adaptation in situations of chronic stress.

Cannon (1932) was the researcher who first labeled the somatic response as the "fight or flight response". In a series of animal studies, he noted that the body prepares itself for one of two modes of instant action: to attack or fight and defend oneself from the threat, or to run and escape the impending danger. The "fight or flight response" is sympathetic nervous system stimulation to prepare for muscular activity in response to a perceived survival threat. The sympathetic response includes an increase in heart rate, blood pressure, muscular strength, and rate of respiration, and a decrease in gastric movement and abdominal blood flow to allow blood to go to working muscles. The "fight or flight response" is triggered by emotional arousal, such as anger, aggression, or fear. The "fight or flight response" adds a critical, relevant dimension to Selye's concept of stress. Selye was primarily concerned with somatic stress, but, Cannon's observations proposed that the mechanisms of adaptation may be called into play in response to emotional stimuli as well (Cannon, 1932).

Selye (1976) described stress as an individual's response to any situation that causes an alteration of homeostasis. Selye reported that in order to help people control anxiety during stressful situations, there must be an understanding of how individuals and their stress responses differ. Nideffer (1976b) suggested that each individual has a slightly different stress response depending on their learning background and experience and the particular situation encountered. Stress responses can be divided into three general categories: cognitive, physiological, and behavioural. Nideffer specified that these three domains support and maintain one another and that each individual's response to stress may include one or more of these components. Gould and Krane (1992) indicated that most responses that occur in athletics are usually considered to fall into the cognitive and physiological domains. The behavioural domain is assumed to be eliminated through the familiarisation with a skill that accompanies the physical training and practice required to become a skilled athlete. The cognitive and physiological domains are primarily concerned with how thoughts, images, and physiological reactions interfere with information processing and physical performance (Gould & Krane, 1992).

Selye (1976) has been careful to point out that there is a clear distinction between stress and stressors. Stress is a biological adaptation response, whereas a stressor is the agent that elicits or evokes that response. Selye has provided a classification of stressors. Recognising that he was primarily concerned with physical stressors, his taxonomy represents little clarification of distinctions or commonalities among psychophysiological stressors. Selye has offered the following list of stimulus categories for eliciting an adaptive stress response: drugs, diet, trauma, biorhythms, environment, physiologic states, muscular exercise, athletics, occupation, tumors, and hypoxia, that is, decreased barometric pressure including hyperbaric oxygenation. This listing illustrates a broad range of potential stressors.

One psychological view of stress that has been widely used in recent years is the transactional theory of Lazarus and his colleagues (Lazarus, 1966; DeLongis, Folkman, & Lazarus; 1988; Lazarus & Folkman, 1984). Lazarus considered stress, and the coping response made to it, to represent a transactional process between the person and the environment. In this view, the recognition that a situation is stressful is based on cognitive appraisal of the demands of the situation and the resources of the person. This depends on characteristics of the person, such as trait anxiety, locus of control, and personality hardiness, and perception of the situation. The stress process is considered to be transactional, rather than interactional, because reappraisals of the demand and resources occurs, based on the changing status of personal and environmental factors. For example, news that one must play a feared opponent in the next round of a major event could be highly stressful for an athlete, because it is appraised as a demanding task. Further information that the opponent has recently been ill and looked tired and weak in her previous match is likely to lead to a downward reappraisal of the demand, consequently, leading to the stress being reduced. Assessment of the demands and ones resources to cope with them, is called primary appraisal. Secondary appraisal involves deciding on the ways in which one will attempt to cope. The conception that demands, resources, and coping are constantly reappraised seems to be important to understanding stress, which is modified on the basis of such reappraisal processes.

Stress and Illness

Allen and Hyde (1981) have proposed that stress can be linked to most physical disease and maladies. Many researchers support this statement and have documented the physiological response of biological organisms during stress. Selye (1976) has demonstrated the effects of stress on the physical health of biological organisms in many experiments. By exposing laboratory animals to various stresses for prolonged periods of time, Selye was able to produce diseases of the kidney and heart, as well as producing fatigue in these animals. Roseman and Friedman (1974) related stress to heart disease by showing that the Type A behavior pattern is conducive to the development of heart disease. Through much experimentation, Roseman and Friedman found that Type A personalities, which are characterised as those who are aggressively involved in the incessant, chronic struggle to achieve more and more in less and less time, discharged more epinephrine and norepinephrine than others. Further, Type A personalities exhibited increases in blood levels of cholesterol and fats, a marked increase in the tendency for the clotting elements of the blood to precipitate out of the body, a lag in the body's ability to rid the blood of cholesterol added to it by food ingestion, and a pre-diabetic state. All these factors enhance the probability of coronary heart disease.

Allen and Hyde (1981), using the general adaptation syndrome as a theoretical base, constructed a psychosomatic model of the way in which stress leads to the development of disease or illness (Figure 2.2). They contended that for stress to result in illness or disease, the mind (psyche) must first perceive and appraise the stimulus as harmful, and then the body (soma) will respond in a variety of ways which could possibly lead to disease. According to Allen and Hyde (1981), the sensory stimulus is generally an external or environmental event, such as a financial problem or traffic jam, which may be perceived as stimulating. This is followed by the next step, cognitive appraisal, where the stimulus is determined to be dangerous or not. If an event is considered dangerous, emotions are aroused causing physiological responses of the nervous and endocrine systems during the stage referred to as the mind/body connection.

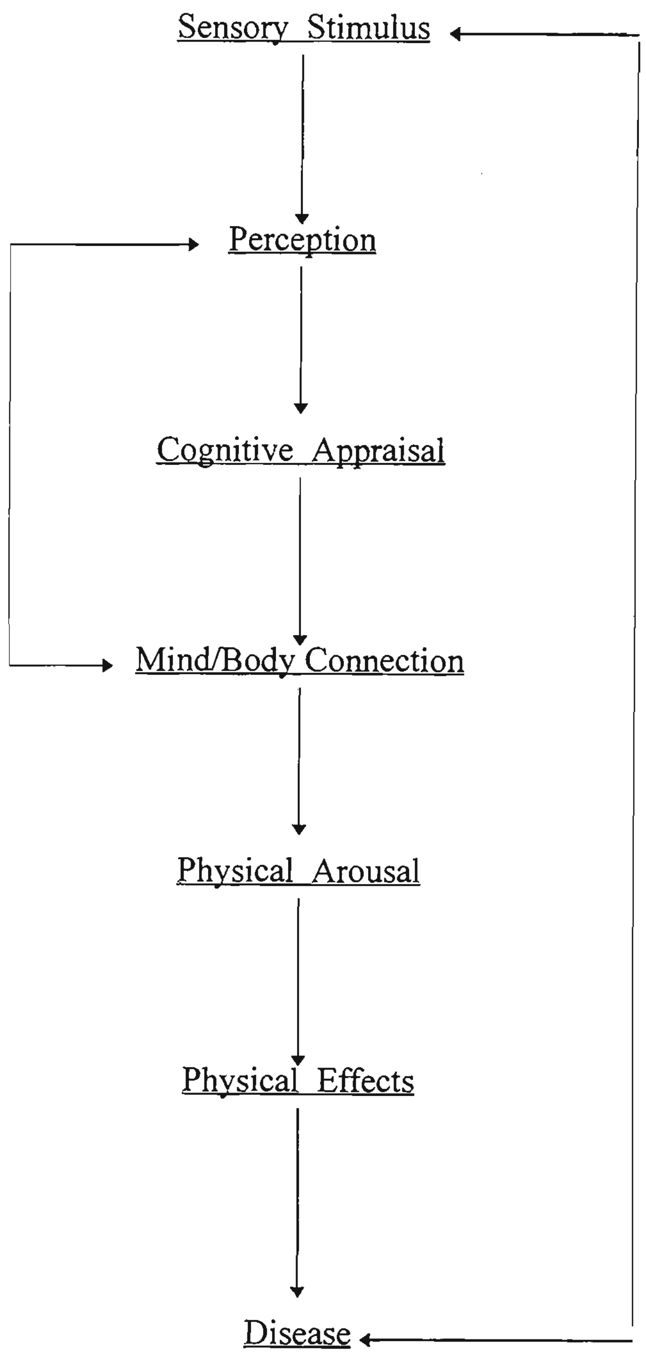


Figure 2.2. The psychosomatic model (adapted from Allen & Hyde, 1981)

These physiological responses lead to physical changes such as increased heart rate, increased blood pressure, increased glucose and serum cholesterol levels, and decreased T-lymphocytes, which could lead to decreased immunity over a prolonged period of time. Then, depending on the intensity of the stimulus, this pattern of changes may develop into a disease or illness. A disease or illness may also serve as a sensory stimulus that thereby makes the model cyclic in nature, and over time increases the severity of the disease or illness.

The concept of stress has received a great deal of attention in relation to psychology and health, particularly in the last 30 years. There is no doubt that it plays an important role in the genesis and the progression of illness and is related to the experience of pain (Allen & Hyde, 1981). Cognitive appraisal appears to be a key process in the perception of stress. Any environmental or internal event has the potential to be stressful, depending on the subjective experience of the individual (Lazarus & Folkman, 1984). Nonetheless, major life events, such as a death in the family or moving house, as well as everyday occurrences, such as meeting deadlines or arguing with family members, seem to play a consistent role in creating stress (DeLongis et al., 1988). Sport competition is inherently stressful. Combined witth the stress experienced in life, this means that athletes are likely to experience relatively high levels of stress while they perform. In sports where physical injury can occur when errors enter performance or when concentration is distracted, high stress levels could increase the potential for injury. It is, thus, likely that stress is often involved in sports injury, and that appraisal of environmental and internal events is an antecedent of the stress that is experienced. Application of this conception of stress is proving to be a fruitful approach to the prediction and control of injuries in sport and this issue is discussed in depth in the next section.

Stress and Sports Injury

Models of Stress and Sports Injury

In the athletic domain a model of the stress and injury relationship developed by Andersen and Williams (1988) offers various predictor variables of sports injury, examines possible mechanisms underlying the stress-injury relationship, and suggests specific interventions for reducing the risk of athletic injury. Their model came about from consideration of a combination of the stress-illness, stress-accident, and stress-injury literature, a similar approach to that adopted around the same time by Smith and Ascough (1985).

Smith and Ascough developed a stress model that was designed with the aim of reducing the incidence of stress through the use of intervention. The four core variables of the model of stress are the situation, the cognitive appraisal, the physiological response, and the resulting behavioural response. Smith and Ascough proposed that when individuals experience stressful situations they appraise whether or not their resources can meet the situational demands, and also appraise the outcome of succeeding or failing to meet these demands. This cognitive appraisal may affect the individuals' physiological response, that may in turn affect further cognitive appraisals of the situation, resulting in a bidirectional influence. The results of the stress response may then be perceived as a behavioural outcome. Smith and Ascough have pointed out that personal and environmental factors such as personality and motivation directly affect the four components of the model of stress. Smith, Smoll, and Ptacek (1990) noted that cognitive appraisal processes include individuals' appraisals of the situational demands and their appraisals of the resources that they possess to cope with these demands. The resources may be either personal ones, such as the appraised adequacy of coping skills, or environmentally based, such as the amount of social support that is available from others. Also, Smith and Ascough proposed that intervention techniques, such as cognitive restructuring, relaxation skills, and coping resources, can be used during the stress response to positively affect the situation.

May and Sieb (1987) suggested a model of stress and injury using the Yerkes-Dodson Principle (Yerkes & Dodson, 1908) (Figure 2.3). The principle is frequently used to show the relationship of stress and tension to performance efficiency in sports, but May and Sieb believed the principle explains injury as well. The main points of the principle are when an athlete is experiencing low levels of arousal, concentration, and awareness and when motivation is not at optimal level for satisfactory performance, athletes' performance may decrease in efficiency and that may increase the risk of injury. As the athletes' arousal level approaches a moderate point, performance will be optimal, causing injury rate to be low. Finally, as arousal becomes intense, performance level again diminishes, causing error and injury rate to go up.

Research on this model currently provides limited useful information about the relationship between stress and injury, and stress and performance, because no research specifically testing the model is reported to support the relationship, shown in this model, between low stress, poor performance and high levels of injury. Unless researchers address this model as a potential explanation of the stress-injury relationship, its utility will remain undetermined.

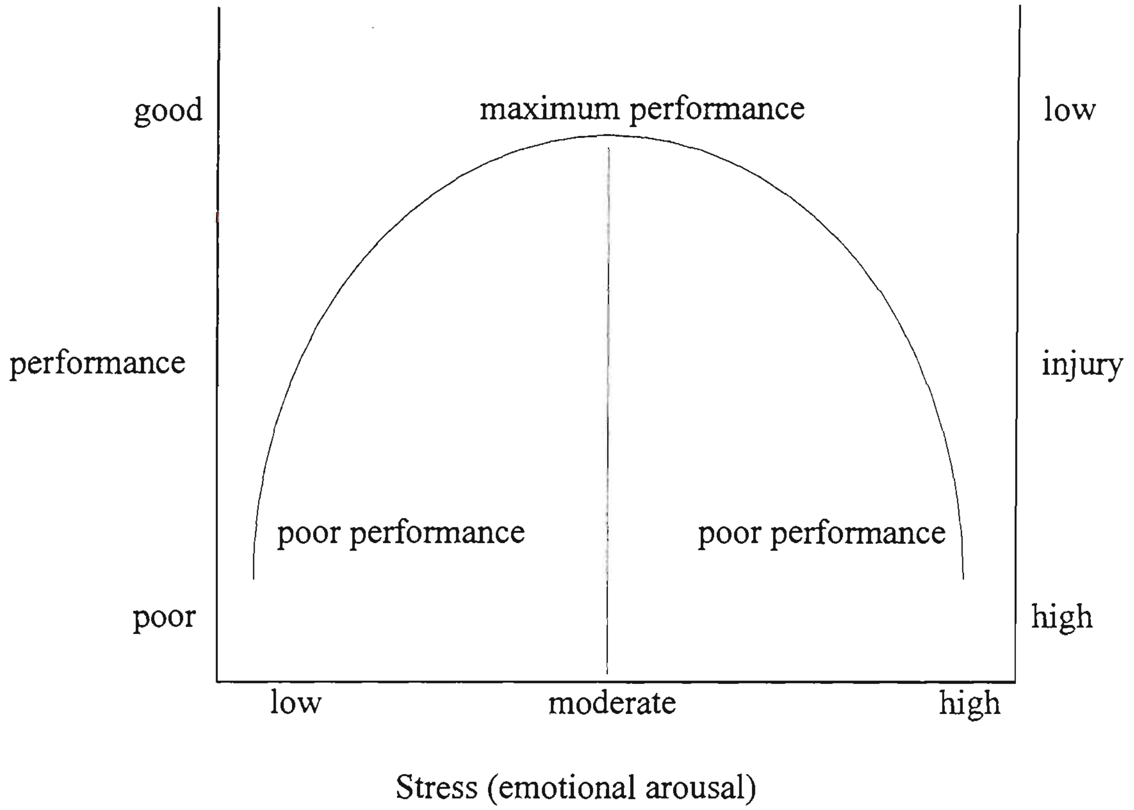


Figure 2.3. The Yerkes-Dodson principle

Andersen and Williams (1988) proposed a framework for prediction and prevention of athletic injury, which is depicted in Figure 2.4. The central part of the model refers to sport situations where injury could occur (potentially stressful sport situations) and mechanisms associated with stress that mediate between the situation and the probability of injury. The three proposed mechanisms that underlie the stress-injury model are increased general muscle tension, narrowing of the visual field, and increased distractibility during a stressful situation (Andersen & Williams, 1988). These are affected by the person's cognitive appraisal of the situation, with two-directional arrows in the figure indicating that the experience of attentional disruptions or muscle tension can be appraised as stressful themselves. The level of tension and attentional deficits are moderated by a range of variables of three types: (a) history of stressors (e.g., life events, daily hassles, previous injuries); (b) personality (e.g., competitive trait anxiety, hardiness); and (c) coping resources (e.g., stress management, social support, mental skills).

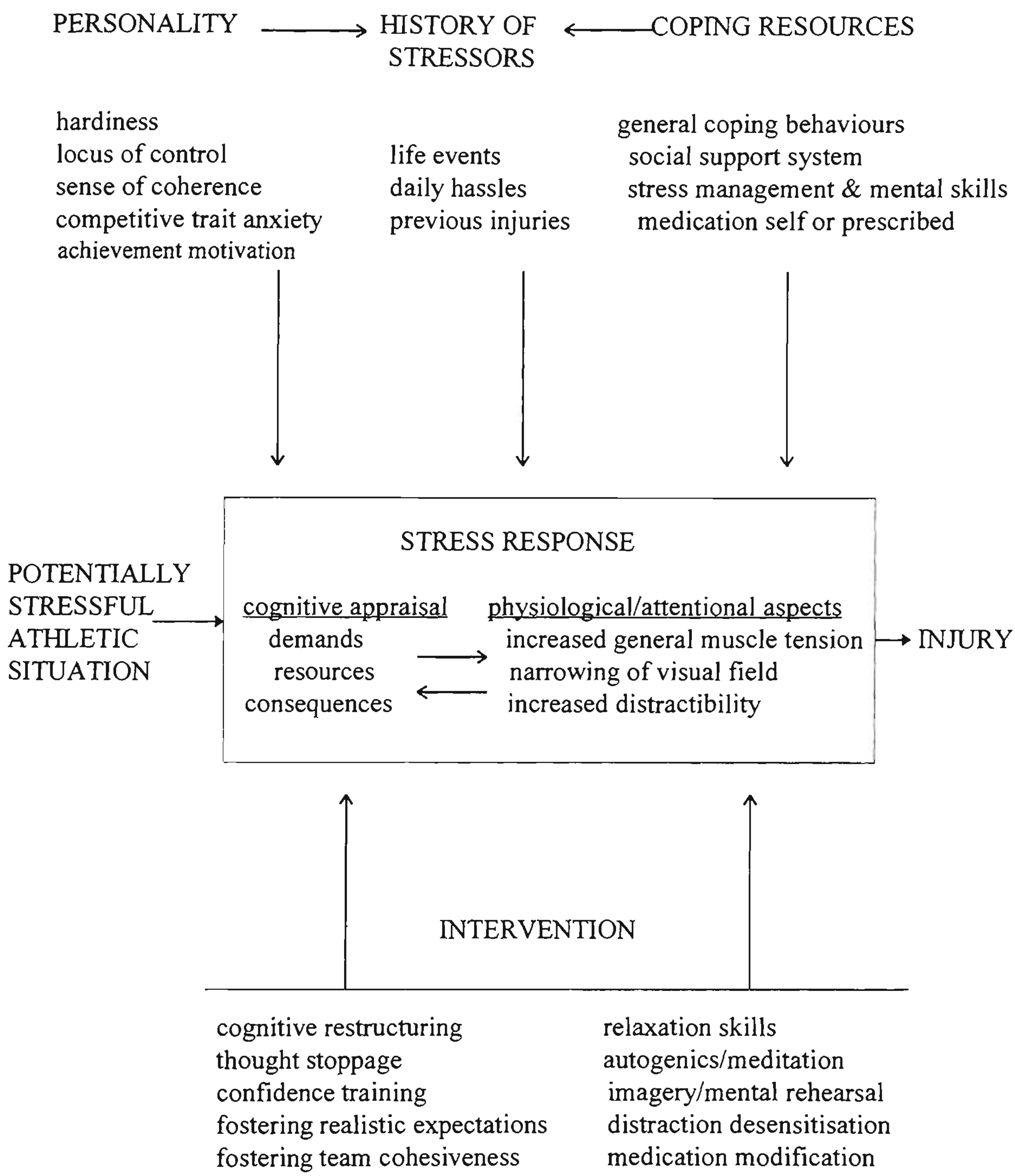


Figure 2.4. A model of stress and athletic injury (adapted from Andersen & Williams, 1988)

These moderators are displayed at the top of the figure. Personality and coping factors are predicted to moderate the effect of life events on the stress mechanism, as indicated by the horizontal arrows from personality to history of stressors and from coping resources to history of stressors. Personality, coping resources, and history of stressors also affect the stress response directly. Andersen and Williams proposed that various interventions would be predicted to affect either the cognitive appraisal or the physiological/attentional aspects, leading to a reduction in the effect of stress on injury incidence. Interventions to change cognitive appraisal include cognitive restructuring, thought stoppage, confidence training, fostering realistic expectations, and fostering team cohesiveness. To address the physiological/attentional aspects of the stress response, interventions include relaxation skills, autogenic training, imagery, meditation, and medication modification, which could reduce muscle tension, enhance attention, or affect both attention and muscle tension. The model is similar in many respects to that developed by Smith and Ascough, although the latter was not developed specifically for the sport injury context. The Andersen and Williams model has advantages, because, having been developed in the stress-injury context, it addresses possible mechanisms underlying the stress-injury relationship and gives suggestions of preventive measures to decrease the likelihood of injury.

The psychosocial stress-injury model appears to have potential for understanding important processes that affect the incidence of injury and for suggesting interventions to reduce injury in sport. It raises a range of testable hypotheses, some of which form the focus of this thesis. Each area of this model is, thus, examined in detail. First considered are the psychosocial antecedents of sports injury, then, mechanisms underlying the stress and sports injury are discussed, and, finally, the issue of intervention is examined. Following the description of the aspects of the model, the main ways in which variables have been measured are discussed and then research related to the model is discussed.

Psychosocial Antecedents of Sports Injury

Above the stress response core of the model, three major categories of variables that can directly affect injury or act as moderators are identified in Figure 2.4; personality factors, history of stressors, and coping resources. Williams and Roepke (1993) noted that

> according to the model, individuals with certain characteristics from these three areas may be more likely to appraise potentially stressful external situations as threatening and, therefore, experience an elevated stress response. It is hypothesized that one's stress history contributes directly to the stress response, while personality factors and coping resources act on the stress response either directly or through a moderating influence on the effects of the history of stressors (p. 820).

In the Andersen and Williams (1988) model of stress and sports injury, it is proposed that a person's history of stressors (e.g., life events, daily hassles), personality (e.g., competitive trait anxiety, hardiness, locus of control), and coping resources (e.g., stress management, social support, mental skills) may have an influence on the magnitude of the stress response when an athlete is in a stressful situation, and thus increase or decrease injury risk.

History of stressors. According to the model, a number of variables may have a substantial direct impact on the stress response. This includes life events, daily hassles, and previous injuries. A majority of early studies examining the relationship between life stress and sports injury focused on the influence of only major life events. This narrow focus within the stress and athletic injury research has been considered a weakness by Williams and Roepke (1993). To make the history of stressors aspect of the model more comprehensive, Andersen and Williams (1988) identified the impact of daily problems and previous injuries, as well as major life events, in their stress and athletic injury model. Daily hassles have been proposed as an alternative to major life events as a measure of stress (Delongis et al., 1988). Daily hassles refer to experiences and conditions of daily living that have been appraised as minor irritating events to the person's well-being (Lazarus, & Folkman, 1984). They include, for example, taking care of paperwork (e.g., paying bills, filling out forms), job deadlines, minor family sickness, arguments with family members or friends, and transportation problems (e.g., car breaking down, missing the bus). The previous injuries incurred by an individual may be an important factor for the prediction of future injury. If an athlete recovers from an injury physically, but is not psychologically ready to return to participation, the athlete may have a negative cognitive appraisal and pronounced stress response, that may predispose the athlete to further injury. Also, the athlete may have a fear of reinjury that may cause an extreme stress response, in turn, increasing risk of injury.

Personality. One important group of factors that Andersen and Williams (1988) proposed influences the stress-injury relationship is personality variables. Personality was defined as a compendium of stable traits that characterise the way in which an individual thinks, behaves, feels, and reacts. Personality factors that could play a role in the stress-injury model include hardiness, locus of control, sense of coherence, competitive trait anxiety, and achievement motivation. Of the five personality factors, researchers have focused mainly on locus of control and competitive trait anxiety because of their direct relevance to sport.

Locus of control refers to a person's belief in whether or not a contingency relationship exists between that person's behaviours and the outcome of those behaviours (Cox, 1990). An internal locus of control is a predisposition to perceive that such a contingency does exist, whereas those with an external locus of control, believe that what happens to them is due to factors beyond or outside their control (Rotter, 1966). When an individual perceives that an event is the result of luck, chance, fate, or under the control of powerful others, this has been labelled external locus of control. Passer and Seese (1983) stated that "the relationship between life stress and variables such as illness and depression has been found to be significant for persons who perceive undesirable events as uncontrollable but non-significant or weaker for individuals who perceive such events as under their control" (p. 12). Thus, in a practical sense, those who perceive stress to be damaging, and perceive intervention as a means to control the damaging effects of stress are more likely to have an internal locus of control.

Another personality factor, which has implications in the perception of stressful situations, is competitive trait anxiety. Competitive trait anxiety has been identified as a tendency to perceive competitive situations as threatening and to respond to these situations with feeling of apprehension or tension (Martens, 1977). Andersen and Williams (1993) proposed that

> high competitive trait-anxious athletes, when placed in stressful situations, exhibit strong stress responses and thus are more likely to incur injury. The roles of sensation seeking and achievement motivation in injury are at present

speculative. Perhaps sensation seekers may actually be at greater risk of injury because of their willingness to take chances (p. 55).

The attention given to locus of control is understandable, based on the substantial amount of research on its role in health (Fawkner, 1995), as is the focus on competitive trait anxiety, the most widely researched trait in sport psychology (Martens, Vealey, & Burton, 1990). It is, nonetheless unfortunate that the other personality variables suggested by Andersen and Williams (1988) have not received similar consideration. It should also be stressed that in referring to locus of control, competitive trait anxiety, hardiness, sense of coherence, and achievement motivation, Andersen and Williams did not intend to suggest that these were the only personality variables that should be considered. They were put forward as variables that had previously been linked to illness, injury, or performance decrements, in the health, exercise, and sport psychology literature. Other personality variables, such as risk-taking, sensation seeking, impulsivity, or extroversion, might equally be linked to the experience of stress or the incidence of injury (Smith, Ptacek, & Smoll, 1992).

Coping resources. Andersen and Williams (1988) proposed that an athlete's coping resources are comprised of their general coping behaviours, social support systems, stress management and mental skills, and medication, self-determined or prescribed. Andersen and Williams stated that "general coping behaviors is a category containing several diverse behaviors that may influence an athlete's overall stress level" (p. 302). Categories of general coping resources include sleep patterns, exercise habits, eating habits, and time management. Andersen and Williams noted that two possible relationships exist between coping resources and the occurrence of injury.

Coping resources may directly affect the risk of injuries through their influence on the stress response or they might moderate the impact of life stress on injury vulnerability.

Social support is the support given by family, teachers, friends, and significant others that athletes know and upon whom they feel they can depend. Andersen and Williams (1988) reported that when an athlete has high social support, this social support may act as a buffer against stressful life events and daily hassles, thus reducing their effect on injury. This is an example of a moderating effect. When there is a problem in an athlete's social support, this could influence responses to stress, so that life stress increases, which, in turn, increases an athlete's vulnerability to injury. A number of studies indicated that low levels of social support were associated with greater risk of injury (Andersen & Williams, 1997; Petrie, 1993a; Smith, Smoll, & Ptacek, 1990).

Andersen and Williams proposed that stress management and mental skills could affect athletic performance and response to stress. Athletes with good stress management techniques are more likely to cope better in stressful situations, thereby decreasing the risk of injury. Athletes with poor stress management techniques are likely to find such situations more stressful, causing a greater stress response and increasing the risk of injury. Again, stress management techniques can affect the stress response directly, by changing appraisal, reducing muscle tension or enhancing attention, but they can also play a moderating role, by minimising the impact of life events or daily hassles.

The last coping resource listed in the model is medication, which can be self-determined or prescribed. Andersen and Williams (1988) noted that "drug use is prevalent in athletes for legitimate as well as illegitimate reasons" (p. 303). They suggested that many drugs could affect cognitive perception, the stress response, injury probability, and performance. Therefore, coping resources such as general coping behaviors, social support system, stress management and mental skills, and medication, may directly or indirectly affect the stress response, as well as the occurrence of athletic injury.

Mechanisms Underlying the Stress and Sports Injury Relationship

The Andersen and Williams (1988) model of stress and sports injury suggested that an elevated stress response in athletic situations, and particularly, the accompanying muscle tension and attentional disruptions (narrowing of the visual field and increased distractibility), increases the risk of athletic injury. The central component of the stress-injury model, the stress response, is a bidirectional relationship between an athlete's cognitive appraisal of a potentially stressful situation and the physiological/attentional aspects of the resulting stress response. Cognitive appraisals stem from situations athletes face and are dynamic with a continual appraisal and reappraisal of the situation. Andersen and Williams (1988) hypothesised that, "in response to stressful situations (e.g., competition, practice, selection to first or second string), the athlete appraises the demands of the situation and his or her ability to meet those demands (resources)" (p. 298). If the athlete perceives his or her resources to exceed demands, the stress response may be minimal, but if demands exceed the athlete's resources, the stress response may be extreme. Also, if the consequences of the event are perceived as negative to the athlete's career or self-esteem, the stress response may be substantial. If the cognitive appraisal is perceived as negative, the appraisal of the stressful situation may predispose the athlete to injury, because of attentional and physiological changes associated with the stress response to such an appraisal.

Physiological responses to stress have been documented. Andersen (1988) found an increase in generalised muscle tension of participants faced with a stressful situation, which may be one of the mechanisms underlying the stress-injury relationship. Andersen reported that generalised tension can lead to the athlete experiencing fatigue, and a decrease in flexibility, motor coordination, and muscle efficiency. Attentional disruption due to stress may be one of the mechanisms underlying the stress-injury relationship. Attention is defined by Martens (1987) as "the process that directs our awareness as information becomes available to the senses" (p. 138). Schmidt (1982) specifically defined attention as a limited capacity to process information and emphasised that this limited capacity is a major characteristic of attention. Attention involves the ordered or serial process of attending to stimuli, which requires that attention must be switched to various stimuli during activities (Schmidt, 1982). Selective attention is the mechanism that directs this attention switching. The efficiency of selective attention varies according to the level of experience or learning stage of the individual (Marteniuk, 1976). Kahneman (1973) stated that as arousal increases, a progressive narrowing of cues takes place as well as the increased occurrence of attentional shifts to various stimuli. Thus, the possibility exists that many relevant stimuli will be excluded when arousal levels are too high. Nideffer (1976b) also proposed that attentional skills, and their management when arousal increases, have a substantial impact on performance, for example, a quarterback in football who can attend to many external cues and strategies should be more successful than another quarterback who does not possess such attentional skills. Williams, Tonymon, and Andersen (1990, 1991), Williams and Andersen (1997), and Andersen and Williams (1997) found a narrowing of the visual field when athletes are put into a stressful situation. This narrowing of the visual field may cause a failure to pick up vital cues from the surrounding environment, which may increase the chance of injury.

Interventions to Manage Stress

In the model of psychosocial variables and injury in Figure 2.4, there are two categories of interventions that are designed to reduce the stress commonly experienced in a variety of settings. These interventions may also influence moderator variables of coping resources and personality factors. Interventions for the cognitive appraisal of the stress response are aimed at changing cognitive processes. They include techniques such as cognitive restructuring and thought stoppage. Interventions that are intended to affect the physiological/attentional changes of the stress response include techniques that have a direct influence on bodily relaxation, such as relaxation skills and attention (e.g., distraction desensitization) (Andersen & Williams, 1988).

Intervention techniques can be distinguished into somatic techniques, used to change bodily sensations, and cognitive techniques, used to alter the individual's cognitive appraisal of stress or change attentional focus (Harris & Williams, 1993). Common relaxation techniques reported in the stress management literature are progressive relaxation (PR), and breathing control exercises. The technique of PR was developed by an American physician, Jacobson (1930). The PR technique emphasizes the relaxation of voluntary skeletal muscles, that is, all muscles over which one has conscious control. PR involves systematically isolating one specific muscle group, tensing those muscles and holding the contraction for several seconds, then relaxing the same muscle group for 10 seconds or so, before moving on to the next muscle group. Breathing control exercises enhance athletic performance by helping the athlete to relax, while also facilitating the physiological demands of exercise by increasing the oxygen supply to the muscles. When athletes become anxious in a competitive situation, it is common for their breathing to become rapid and shallow, or for the athlete to simply hold their breath. These disruptions to breathing in turn create more tension, to ultimately impair performance further. Breathing control is considered a relatively easy technique to develop and learning to take deep, slow breaths will often facilitate a relaxation response (Davis, Eshelman, & McKay, 1995).

The other category of relaxation techniques, focuses on language and suggestion to help generate a relaxation response (e.g., autogenic training (AT), Benson's relaxation response, meditation, imagery). AT is perhaps the most widely used approach to relaxation in Europe (Zaichkowsky & Takenaka, 1993). This technique was developed by Johannes Schultz (1932), and elaborated by Wolfgang Luthe (1969). AT takes participants through six standard exercises that involve covertly repeating verbal formulas designed to suggest heaviness and then warmth in the extremities, calm and regular heart beat, slow breathing, abdominal warmth, and a cool forehead. AT involves systematic practice, coupled with 15 to 30 minutes of post practice relaxation (Zaichkowsky & Takenaka, 1993). AT has been considered to be one of the most effective and comprehensive relaxation skills (Davis et al., 1995). Davis et al. stated that

> AT has been found to be effective in the treatment of various disorders of the respiratory rate (hyperventilation and bronchial asthma), the gastrointestinal tract (constipation, diarrhea, gastritis, ulcers, and spasms), the circulatory system (racing heart, irregular heartbeat, high blood pressure, cold extremities and headaches), and the endocrine system (thyroid problems). AT is also useful in reducing general anxiety, irritability, and fatigue. It can be employed to modify your reaction to pain, increase your resistance to stress, and reduce or eliminate sleeping disorders (p. 82).

Luthe (1969) reported that the most important factor in eliciting the AT response appears to be a passive attitude. The definitive difference between active concentration and passive concentration used during AT lies in the person's attitude toward the functional outcome to be achieved. Passive concentration refers to a nonstriving attitude and passive activity, whereas active concentration is characterised by the person's concern, interest, and attention during the AT and in respect to the final, functional result. Because this thesis employs AT for stress management, this technique will be discussed in more detail, in the Method section of Chapter 5. AT, and modifications of the basic technique, have been found to be effective in the management of stress and anxiety, which are closely connected to injury outcome (Zaichkowsky & Takenaka, 1993).

Another popular technique is Benson's relaxation response. Benson (1975) developed a contemporary meditation method, derived from traditional mantra meditation, called the relaxation response. This is a concentration style of meditation, where the word 'one', or any other chosen sound, is repeated in thought with every out breath. This is repeated for 10 to 20 minutes once or twice daily.

Imagery refers to a multi-modal process which is rich in detail across all senses, creating as vivid and realistic a picture as possible (Suinn, 1993). Various imagery protocols can be used to reduce anxiety, develop technical skills, enhance concentration, and improve self-confidence (Morris, 1997). Imagery can be classified according to the modality of its content; verbal, visual, auditory, olfactory, or kinesthetic. While it can be used in a number of ways to manage the somatic aspects of stress, for example, by imagining oneself in a relaxing environment or by imagining one's heart beating slowly, breathing being slow and deep and so on, imagery can also affect cognitive appraisal, by generating images of effective coping with perceived stressors.

In addition to the latter use of imagery, other intervention techniques can be categorised as cognitive techniques, that are designed to change an individual's cognitions and perceptions of their situation. Thought stopping, rational thinking, cognitive restructuring, and hypnosis are all popular cognitive techniques. Thought stopping is a technique designed to break the link between negative thoughts and associated behaviours. In this technique, athletes learn to interrupt negative thoughts on cue, by briefly focusing on the negative thought and then using a "trigger" to stop the negative thought. The "trigger" may consist of words such as "one", or "stop", and need not be directly related to performance, but must be meaningful enough to the athlete to be acceptable, and consequently effective. If an athlete has difficulty controlling their negative thoughts, cognitive restructuring may be effective. Cognitive restructuring techniques involve changing negative irrational thoughts that an individual firmly believes are true, into constructive rational, and positive thoughts. An example of such a negative thought in sport, is an individual believing that good athletes perform flawlessly, and because that individual makes mistakes they are therefore not a good athlete. These irrational thoughts involve the belief that single events are crucial factors in an athlete's self-image, self-esteem, and future prospects. Another cognitive technique used to control the individual's cognitive appraisal of stress, is hypnosis. Mahoney (1979) defined hypnosis as a process that allows one to experience particular thoughts and images as real. The induction of hypnosis begins with the hypnotherapist identifying the source of the athlete's stress and anxiety. The information generated is then used to formulate appropriate positive suggestions through consultation between the hypnotherapist and the athlete.

Measurement of Psychosocial Factors and Sports Injury

A large number of psychosocial inventories have been employed recently in sport psychology research. These inventories are used to test theories, define and better understand constructs, and communicate athletes' feelings and attitudes. They include measures of life stress, daily hassles, and coping resources, such as coping skills and social support. The measurement of sports injury has also led to the development of a number of devices. A range of major psychosocial and injury inventories that have been used in sport psychology research are described and evaluated in this section.

Life Stress Measurement

Life event stress, hereafter referred to as life stress, is perhaps the most thoroughly researched area in the field of psychosocial factors which relate to sports injury. To measure the impact of stressful life events, Bramwell, Masuda, Wagner, and Holmes (1975) developed the Social Athletic Readjustment Rating Scale (SARRS). The SARRS is a modified version of the Social Readjustment Rating Scale (SRRS; Holmes & Rahe, 1967). The SRRS consists of 43 life events that are believed to evoke some degree of adaptive or coping behaviour. The SARRS consists of a list of 57 events that commonly occur in the lives of athletes. Some items are specific for athletes such as "change of team responsibility" and "trouble with the coach", but there is also a range of general life stressors based on the original SRRS. The SARRS has only one total score. No reliability or validity data were provided for the SARRS. Also, SARRS and SRRS inventories do not require the individual to appraise the event as being either positive or negative, that is, they do not distinguish between pleasant experiences and undesirable events. It is likely that undesirable events, which form the basis for negative life change, may have a different and possibly more detrimental effect on an individual than positive events.

The Life Experience Survey (LES) was developed as an alternative method, of measuring life stress to the SARRS, by Sarason, Johnson, and Siegel (1978). The major change in the LES, compared to previous life stress measures, is that it differentiates between positive and negative response to the events. The LES consists of 60 items that list major life events such as "marriage", "new job", and "death of a friend". Participants are instructed to check an event if it happened within the past year and give a score of the impact it had. Scores range from -3 (extremely negative impact) to 0 (no impact) to +3 (extremely positive impact). Separate scores for negative life events (NLE), positive life events (PLE), and total life events (TLE) are obtained for each participant. The TLE score is the absolute value of the summed NLE and PLE ratings. Six week test-retest reliabilities on TLE and NLE indicate reasonable reliability, and range from .56 to .88, with the PLE score being less stable, having a range from .19 to .53. The LES is a well constructed inventory compared to the SARRS and SRRS, because the LES provides negative and positive scores, as well as a total score. It was not, however, developed specifically for the assessment of life stress in sport.

Passer and Seese (1983) modified the LES to increase its specificity to collegiate male athletes. They added 10 items that were more relevant to the life events experienced by male collegiate athletes. The new 70-item inventory was titled the Athletic Life Experience Survey (ALES). The ALES items refer to personal changes, family, job, and team problems. Participants check whether they have experienced such a stressor during the past 12 months and, if they have, report its impact in terms of strength and valency (good/ bad). Each life stress is scored by the participants on a scale from +3 (Good) to -3 (Bad). A score of 0 indicates that the event occurred but had no perceived positive or negative effect. Three scores are obtained by summing separately the negative and positive valanced items, and then adding the absolute value of all item scores to produce the third score, a total life-experiences score. Passer and Seese (1983) reported five week test-retest reliability of .66 in an independent sample of 32 physical education students. The strengths of the ALES include that it is a sport-specific inventory and that it provides three scores, positive, negative and total. It is, though, a modified form of a general life stress questionnaire.

In 1987, Compas, Davis, Forsythe, and Wagner reported on the development of the Adolescent Perceived Events Scale (APES). The APES consists of 197 specific life events generated from the reported experiences of a large high school sample (e.g., “parents getting divorced”, “pressures or expectations by parents”, and ”getting good grades or progress reports”). Participants indicate whether they have experienced such a stressor during the past six months and, if they have, report its impact as positive or negative at the time. They also classify the events as either a major event (e.g., having a large effect on your life) or as a “day-to-day” event (e.g., more minor effect). The scores are derived for positive, negative, minor, and major life change. A limitation of the APES inventory is the large number of items (197 items) and thus the time taken to complete it. This might lead to boredom that produces inappropriate responding, as well as errors, because of lack of concentration.

Andersen and Williams (1988) proposed that the current life stress inventories were questionable. Both the ALES and the SARRS, which are the most frequently employed questionnaires in the stress-injury research, are questionnaires created by modifying previous inventories and have little noted reliability or validity data. In an effort to establish a valid and reliable life event stress instrument for athletes, Petrie (1992) constructed the Life Events Survey for Collegiate Athletes (LESCA). The LESCA consists of 69 items that includes events considered stressful for college students and athletes. This instrument is similar to the ALES, because it was designed to assess an athlete’s perception of each event’s impact and desirability (positive versus negative). The perceived impact of those events at the time of incidence is rated on 8-point Likert Scale from +4 (extremely positive) to -4 (extremely negative). Examples of items include: “pressure to gain/lose weight-due to participation in sport” and “not attaining personal goals in sport”. Test-retest reliabilities range from .76 to .84 for one week and .48 to .72 for eight-week retests. Petrie (1992) reported that the LESCA has an extremely low correlation with social desirability. Andersen and Williams (1997) suggest that the LESCA is a reliable and valid measure of life stress in college athletes, because it was developed specifically for use in the college setting. It is still quite long, that is, it has a substantial number of items, but this seems to be inevitable if the range of common life events is to be covered adequately. Effects of length can be minimised by appropriate administration techniques, such as providing periodic short breaks or encouragement. Further work is needed with this measure, but it certainly shows promise.

Daily Hassles Measurement

To measure impact of minor life events, Kanner, Coyne, Schaefer, and Lazarus (1981) constructed the Daily Hassles Scale (DHS). The DHS consists of a list of 117 events that commonly occur in daily living. Participants are asked to indicate which hassles have occurred over the past month and report the perceived impact of each event from 1 (somewhat severe) to 2 (moderately severe) to 3 (extremely severe). Over a period of nine months, the monthly test-retest correlations for daily hassles were .79 for frequency and .48 for intensity, and to determine concurrent validity, the scale was correlated with Bradburn's Morale Scale for negative affect ($r = .34$) (Kanner et al., 1981). DeLongis, Coyne, Dakof, Folkman, and Lazarus (1982) also developed the Hassles and Uplifts Scale (HUS). The HUS consists of a list of 53 events. The participants could rate each item on how much of a hassle or an uplift it is for them that day on a 4-point scale raging from 0 (none or not applicable) to 3 (a great deal). The items include a wide variety of everyday concerns, such as family, health, environmental concerns, finances, work, and social activities. Two hassles scores are obtained by summing separately the negative (hassles) and positive (uplifts) valanced items. Total hassles scores were obtained by summing across ratings given to all items. Burks and Martin (1985) developed the Everyday Problem Scale (EPS) to assess day-to-day hassles. The EPS consists of 34 items, including daily hassles from seven areas; schoolwork, employment, finance, family, living situation, romantic relationships, and other social relationships. Participants are asked to indicate which daily hassles have occurred in the previous two weeks. The total number of marked items constitute each participant's score. The strengths of the EPS are brevity, good predictability, and design for college students. Again, it is not sport-specific, so its sensitivity for the sport context is questionable.

Some of daily hassles studies did not find any significant relationship between minor life events and injury occurrence using these inventories, because of methodological weaknesses (Blackwell & McCullagh, 1990; Hanson et al., 1992; Smith et al., 1990). They measured daily hassles only once, at the beginning or end of the season. Because of their ever-changing nature, there is a need for frequent assessment of day-to-day problems, such as the assessment pattern employed by Fawkner (1995), who measured minor life events on a weekly basis.

Coping Resources Measurement

The most popular inventory measuring psychological coping skill is the Athletic Coping Skills Inventory (ACSI; Smith, Smoll, & Schutz, 1988). The ACSI consists of 42 behavioural self-report items designed to measure a range of general coping skills within a sporting environment. The following are sample items: "I can focus my attention narrowly and block out distractions," and "My emotions keep me from performing at my best." Each item is scored on a 4-point Likert type scale ranging from 0 (almost never) to 3 (almost always). Total scores on the scale can range from 0 to 126. Smith et al. (1988) reported one week test-retest reliability of .88 for a sample of 94 athletes, and it has a high internal consistency, Cronbach's alpha coefficient of .90.

Recently, Smith, Schutz, Smoll, and Ptacek (1995) developed the Athletic Coping Skills Inventory-28 (ACSI-28). The ACSI-28 is a refined 28-item version of the 42-item ACSI. The ACSI-28 contains seven sport-specific subscales: coping with adversity, peaking under pressure, goal setting/mental preparation, concentration, freedom from worry, confidence and achievement motivation, and coachability. Items are scored on a 4-point scale ranging from 0 (almost never) to 3 (almost always). Smith et al. (1995) reported one week test-retest reliability of .87 for a sample of 97 college athletes. They also noted that the ACSI-28 has a high internal consistency, with a Cronbach's alpha coefficient of .86. The ACSI-28 is based on a well-established inventory, and has potential because it is the development of a multidimensional scale that measures relatively distinct psychological characteristics specific to the sport context.

To measure social support, the Stress Audit Questionnaire (SAQ; Miller & Smith, 1982), Social Support Questionnaire (SSQ; Sarason, Levine, Basham, & Sarason, 1983), and Social Support Inventory (SSI; Brown, Brady, Lent, Wolfert, & Hall, 1987) have been developed and used. The SAQ consists of 20 items, seven of which deal with social support (e.g., I give and receive affection regularly) and the other items concern general coping behaviours (e.g., proper sleeping habits and diet). Participants rate each item from 0 (almost always) to 5 (never). High scores on this measure of SAQ indicate poor coping resources. The weakness of the SAQ is that it does not have the degree of specificity that would be desirable in sport-related psychological skills such as concentration, goal setting preparation, and confidence and achievement motivation. The SAQ only measures coping resources, including such resources as social support and regular exercise.

The SSQ consists of 27 items related to various aspects of social support. The SSQ requires respondents to indicate the initials of those who provide the support described by that item and the respondents' overall level of satisfaction with the support received with respect to that item. The responses to the satisfaction component have a 6-point Likert scale ranging from 1 (very dissatisfied) to 6 (very satisfied). The total SSQN score is obtained by summing the number of individuals providing support across all the 27 items and total SSQS scores are obtained by summing the ratings across all the items. Sarason et al. have proposed that the SSQ is a unidimensional inventory (one strong factor accounted for 72% of the variance). Internal consistency (Cronbach's alpha) has been reported by Sarason et al. (1983) to be .97 for the SSQN and .94 for the SSQS, and test-retest correlations over a four week interval was .83. One weakness of the SSQ is that it has a large number of items. Although there are 27 numbered items in the scale, for each item the respondent must list the names of those giving social support and rate satisfaction with the support offered. Sarason et al. have pointed out that the SSQ takes about 15 to 18 minutes to administer and has good test-retest reliability. Its length could lead to errors due to lapses of concentration. Also, it might induce boredom in sports performers, so a sport-specific scale would be preferable.

The SSI consists of 39 items. Participants rate each of the items on a 7-point Likert scale ranging from 1 (none) to 7 (very much), according to the strength of the social support needed (SSN) and the perceived amount of social support received (SSR) during the past month. A total perceived fit score (SS-PF) is calculated by subtracting the perceived supply (SSR) score from the need strength (SSN) score and is summed over all items. Internal consistency of the SSI was determined for a sample of college students and ranged from .79 to .91, with concurrent and construct validity data (Brown et al., 1987). This inventory was developed for use with a college level population.

In general, the majority of the coping resources inventories are designed to measure general psychological functioning. It might be necessary to develop sport-specific instruments, such as the ACSI-28, to measure important variables that are related to sport-specific psychological outcomes.

Injury Measurement

A majority of early injury research used the guidelines established by the National Athletic Injury/Illness Reporting System (NAIRS). The NAIRS is a nationally used questionnaire in the USA for the recording of injury information in sport. The participants were asked to report the following: (a) any injuries which occurred during a specified time interval (usually the last 12 months); (b) an explanation of each injury and its occurrence; (c) the severity of injuries (e.g., minor, moderate, major), that disturbed their training. A minor injury was defined as one where the injured player returned to play within one to seven days. Moderate injury was defined as the player being out of action between 8 and 20 days. Severe injury was defined as occurring when a player was sidelined for 21 days or longer. A limitation of the NAIRS is that it classifies injuries only according to the amount of time loss due to injury. Although athletes may incur minor injuries, sometimes they do not miss a day of practice or competition. This could lead to underreporting of the frequency of injuries and, thus, an underestimate of the stress-injury relationship. Also, missing collegiate play for up to seven days can not really be considered moderate injury (Blackwell & McCullagh, 1990). Due to these restrictions and the insensitive nature of the NAIRS classification to all types of injuries, Blackwell and McCullagh (1990) constructed the Colorado Injury Recording System (CIRS). The CIRS is a more sensitive method of classifying injuries than the NAIRS, which has been used in past research (Passer & Seese, 1983; Williams et al., 1986). Those completing the CIRS are asked to report the following: (a) nature of injury (e.g., strain, sprain, contusion); (b) location of injury (e.g., ankle, knee, finger); (c) type of injury (e.g., practice, competition); (d) severity of injury. According to the CIRS, injuries are classified as mild (treatment required, but no modification of activity), moderate (requiring treatment and modification of activity), severe 1 (non-participation for 1 to 7 days), severe 2 (non-participation for 8 to 21 days) or severe 3 (non-participation for more than 21 days). The CIRS takes into account the situation in which an athlete may be injured, yet does not miss a practice session or competition.

A limitation of the measurement of time loss as a criterion for injury is that the effects of the injury will depend on an individual's subjective responses to the injury. For example, one athlete may play with an injury, but another may not play with the same injury due to differences in personality or pain tolerance. A limitation of measurement of injury severity is that it ignores the impact, or meaning, that the injury has for the athletes. Future injury research should assess injury severity by the use of well-structured interviews, as well as self-report scales, instead of numerical coding, or labeling of athletic injuries.

Research Based on the Stress and Sports Injury Model

Researchers have examined aspects of stress and sports injury for some time. The interactional nature of the Andersen and Williams (1988) model provides a framework for the presentation of the research on various aspects of stress and sports injury. This section of the review of literature considers three major areas: (a) the relationship between psychosocial factors and sports injury; (b) the effect of stress on physiological/attentional changes; and (c) stress management and injury incidence.

Relationship between Psychosocial Factors and Sports Injury

History of stressors research. During the last 30 years, life stress research has frequently focused on sports injury. In 1970, Holmes reported the first study of life stress and athletic injury. He gathered data from 100 American football players on their life change prior to a gridiron football season, using the Social Readjustment Rating Scale (SRRS; Holmes & Rahe, 1967). Then he recorded severity of injury during the following season. The results showed that players who experienced many life events were more likely to incur injury during the season that followed, than players who reported few life events. Later, Bramwell, Masuda, Wagner, and Holmes (1975) developed the Social and Athletic Readjustment Rating Scale (SARRS). The SARRS is a modified version of the SRRS. The SARRS was designed to evaluate an athlete's level of readjustment to life change. Bramwell et al. examined the relationship between stressful life events using the SARRS and frequency of injuries in a sample of 82 gridiron football players. Game and practice injuries were well documented by the Division of Sports Medicine at the University of Washington. An injury record for all participants was obtained at the end of the season. Bramwell et al. found that a positive relationship existed between the extent of changes occurring in an athlete's life and the probability of having an athletic injury. Cryan and Alles (1983) replicated the football injury study by Bramwell et al. (1975) with improvement in the research design. Participants for the study consisted of 151 football players from three universities whereas Bramwell et al. used 82 players from one university. Cryan and Alles used the SARRS to assess life stress. The SARRS was filled out at a team meeting one week before the start of the season for each team. Injury data was collected by the NAIRS throughout the season. Cryan and Alles found that collegiate football players experiencing high life stress were more likely to incur multiple injuries during their playing season. There was no significant difference in injury severity between high, medium, and low life stress groups. The limitation of these studies that used SRRS or SARRS inventories is that these inventories do not distinguish between positive and negative life change. The results might not be so clearcut, because negative life change, such as death of a close family member or divorce, may have a different, and possibly more detrimental effect on an individual, than positive events, such as marriage and outstanding personal achievement. It is noteworthy that despite the suggested lack of refinement of the life stress scores, all the studies found positive relationships.

Passer and Seese (1983) modified Sarason, Johnson, and Siegel's (1978) Life Experience Survey (LES) and developed the Athletic Life Experience Survey (ALES). Passer and Seese (1983) studied the relationship between negative life stress as measured by the ALES, and athletic injury in two teams of 104 university gridiron football players. Time loss from participation was the measure of injury, and injuries were recorded at each university by sport medicine clinic personnel during the playing season. Passer and Seese found that negative life stress had a direct effect on injury outcome in a sample of 49 football players from a NCAA Division II university (small university, independent). There was no relationship between injury and the life stress measures in a sample of 55 football players from a NCAA Division I university (major university, affiliated). May, Veach, Reed, and Griffey (1985) reported the effects of life stress and injury and health problems of an elite alpine ski team. The elite alpine ski team consisted of 73 members ranging from World Cup contenders to developing athletes. The participants completed the SARRS and LES-A to assess life stress and the Health, Injury, and Performance Survey (HIPS; May, Veach, & Southard, 1985) to measure health problems. They found that athletes with higher life stress had experienced more ear, nose, and throat problems during the past year than those with low life stress. They also found a significant correlation between increase in life stress and increase in the use of nonprescription drugs, such as alcohol and tobacco. Also, athletes with higher life stress scores had a greater number and duration of problems, such as headaches, leg injuries, and sleep problems. Although much of the early stress-injury research has mainly focused on college football players, May et al. examined the stress-injury relationship in high risk sports, instead of football, and found significant results.

Williams, Tonymon, and Wadsworth (1986) investigated the relationship between life stress and sports injury. The sample consisted of 179 (111 females and 68 males) NCAA Division I intercollegiate volleyball players from 15 universities, who completed the ALES, SARRS, and NAIRS to assess the stress-injury relationship. The athletes completed the ALES and SARRS scales before the beginning of season, and their injuries were recorded throughout the season by an athletic trainer. Williams et al. found that there was no significant relationship between either the ALES or the SARRS and the incidence of injury, although low coping resources was related to a higher incidence of injury, as discussed in the coping resources research section of this Literature Review. Athletes with high life stress scores had no greater chance of becoming injured than athletes with low life stress scores. This result may be related to the low stress scores shown by the volleyball players in Williams et al. study. It might also reflect the lower frequency of injuries in noncontact sports like volleyball.

In another investigation of a noncontact sport, Kerr and Minden (1988) performed a retrospective study with 41 elite female gymnasts. The Coddington Life Event Record (CLER) was used to measure the athletes' stressful life events and their injuries were recorded using the Gymnast's Injury Questionnaire (GIQ) that they developed for the purposes of this study. The gymnasts' reported injuries that had occurred over the two year period prior to filling out the GIQ, a description of each injury and its occurrence, the timing of the injury in relation to the next competition, and the number of days the injury interfered with regular training. Kerr and Minden found that athletes who had experienced a greater number of life events tended to incur more injuries and the injuries were more severe. The limitation of Kerr and Minden study is that they used retrospective injury reports. They proposed that a prospective design would circumvent these problems by recording life events and injuries as they happen in time. The Kerr and Minden study also did not describe the psychometric properties of the inventories used to assess psychological variables.

Blackwell and McCullagh (1990) examined the relationship between psychological factors and sports injuries in 105 NCAA Division I gridiron football players. The ALES inventory was used to measure the athletes' life stress and their injuries were recorded prospectively using the Colorado Injury Reporting System (CIRS). The athletes completed the ALES scale before the football season began, and their injuries were recorded throughout the season by a certified athletic trainer. Blackwell and McCullagh found that injured athletes scored higher than non-injured athletes on the total score from the ALES inventory. Furthermore, athletes who scored higher (top 25%) on the ALES were more likely to incur injuries than athletes who scored in the low quartile (bottom 25%). Although this is a valuable study, it would have been interesting if a rather more substantial introduction had been included, to fully explain the rationale of the research.

Smith, Smoll, and Ptacek (1990) examined the effect of life stress and time loss due to injury. The 451 high school athletes were males and females who participated in basketball, males who were involved in wrestling, and females from gymnastics. Life stress was measured by using a modified version of the high school form of the

Adolescent Perceived Events Scale (APES; Compas, Davis, Forsythe, & Wagner, 1987). The athletes completed the APES scale before the sport season began, and their injuries were recorded over the course of the season. Their injuries were measured in terms of the total number of days of missed due to injury over the course of the season (i.e., time loss). Athletes classified stressors as a major or minor experience and as a positive or negative event using the APES. Smith, Ptacek, and Smoll (1992) also measured the effect of life stress and the time loss due to injury. The 425 high school athletes were males and females who participated in basketball, males who were involved in wrestling, and females from gymnastics. They used the same method to measure life stress and injury in Smith et al. (1990) study. Two Smith et al. (1990, 1992) studies found that major negative life stresses were directly related to time loss due to injury. Although the results of the two Smith et al, studies showed significant relationships between life stress and sports injury, life event stress scores may not have accurately reflected the impact of each event, probably due to the relatively coarse life stress categories. On the other hand, because the APES consists of a very large number of items (197), scores on it could be affected by lack of motivation or boredom, as well as errors due to lapses of concentration.

Hanson, McCullagh, and Tonymon (1992) examined life stress and injury in a sample of 181 (58 females and 123 males) NCAA Division I and II university track and field athletes. The athletes completed the ALES to assess stressful life events, and their injuries were recorded prospectively using the CIRS. The athletes completed the ALES scale before the season, and their injuries were recorded during the season (18 weeks) by certified athletic trainers at each university. Trainers recorded the total number of days of missed practice due to injury. Hanson et al. found that athletes with high positive life stress scores sustained more frequent injuries than athletes with low positive life stress scores. This indicated that positive life stress can have a deleterious effect on athletic injury outcome. Generally, most life stress and athletic injury research has focused on the negative aspects of life stress, more than positive life stress (e.g., Cryan & Alles, 1983; Passer & Seese, 1983; Petrie, 1992, 1993a; Smith et al., 1992; Smith et al., 1990). Hanson et al., however, found that positive life stress also can be related to athletic injury. For example, life events such as "Being moved to a higher playing status; reserves to league" or "Major increase in team responsibilities; captain, vice captain" could be reported as being extremely positive by athletes, but were also associated with a greater incidence of injury.

Petrie (1992) conducted three life stress-injury studies using the Life Events Survey for Collegiate Athletes (LESCA) inventory to measure the athletes' major life events. Petrie (1992) examined the effects of life stress and sports injuries of 103 NCAA Division I-A female gymnasts. Their injuries were recorded by the university's medical/training staff prospectively throughout the season as the number of games missed and the total number of days absent because of injury. Petrie also compared the LESCA and the SARRS as measures of life stress. He found that injured athletes had experienced more negative life stress than non-injured athletes. The results also indicated that higher levels of negative life stress were associated with an increased likelihood of minor injuries, a greater total number of injuries, and more time loss due to injury. Petrie found that the LESCA provided a construct-valid assessment of life stress and was a better predictor of sport injury than the SARRS. Petrie (1993a, 1993b) prospectively investigated the influence of life stress on the incidence of sport injury in NCAA Division I-A collegiate football players. Their injuries were recorded by training staff as the total number of days of missed practice due to injury during the season. In the first study (1993a), he found that negative life stress was directly related to the number of games missed and the total number of days absent due to injury. In the second study (1993b), he found that only higher levels of positive life stress were associated with increases in the number of days missed due to injury. He also discussed the impact of high life stress on athletes and concluded that it affected interpersonal relationships in home, work, and social settings, as well as having a major effect on injury outcome. This result provided support for the Hanson et.al. (1992) study that found that positive life stress could affect on athletic injury outcome. Petrie's work is a valuable contribution, first because he developed and used a sport specific measure of life stress and second because a series of three studies was conducted across different samples, but using the same method.

Recently, Andersen and Williams (1997) examined the life stress and sports injury relationship. The sample consisted of 196 (117 females and 79 males) NCAA Division I university athletes from 10 sports, who completed the LESCA to assess stressful life events at the beginning of their seasons. Within a prospective research design, the athletes were then followed for an entire season and their injuries were recorded as the number of injury events. Measures of life stress were used as predictors of number of injury events in stepwise multiple regression analyses. Andersen and Williams (1997) found that negative life stress was an important predictor of the number of injuries. As well as providing support for the relationship between life stress and athletic injury, these results were consistent with the studies by Petrie (1992, 1993a,).

Lazarus and Folkman (1984) hypothesized that daily hassles would be even more detrimental to health than major life events. They described hassles as daily interactions with the environment that were basically negative, and pointed out how these could take a significant toll on health. Financial problems, drinking too much, losing sleep, upsetting news events, and traffic jams are examples of these hassles. Delongis, Folkman, and Lazarus (1988) examined the effect of daily hassles on health and mood. The participants consisted of 85 couples who were selected by random-digit dialing. The participants completed the HUS to assess minor life events and the Daily Health Record (Verbrugge, 1985) to measure health and mood. The participants reported these scales once a week for six months. Delongis et al. found that there was a tendency for an increase in daily hassles to be associated with a decline in health and mood. Although the health literature has found a relationship between daily hassles and illness, only a few studies have been conducted examining the connection of daily hassles and sport injury (Blackwell & McCullagh, 1990; Fawkner, 1995; Hanson et al., 1992; Smith et al., 1990). Blackwell and McCullagh (1990) found that there was no significant relationship between minor life events, assessed by the Daily Hassles Scale (DHS; Kanner, Coyne, Schaefer, & Lazarus, 1981) and incidence of injury. The DHS scale was administered at the end of regular season play, and the injuries incurred by 105 football athletes were recorded throughout the season using the CIRS. Smith et al. (1990) using 451 male and female high school athletes from various sports, found no relationship between minor life events and occurrence of injury. The limitation of this study was that a single questionnaire (APES) was used to measure both major and minor life events and assessed them only at the beginning of the season. Hanson et al. (1992) also examined the daily hassles and sports injuries of 181 collegiate track and field athletes with a modified version of Burks and Martin's (1985) Everyday Problem Scale (EPS). The athletes completed the EPS scale before the beginning of the season and their injuries were recorded by certified athletic trainers during the season (18 weeks). Hanson et al. found that there was no significant relationship between daily problems and sports injury. Again, a weakness of this study was that it measured minor life event only at the beginning of the season. Because of their everchanging nature, daily hassles need frequent measurement during the athletic season to be sensitive predictors of injuries in the period following that specific daily hassles measure. Recently, Fawkner (1995) examined daily hassles and sports injury, employing such a design (i.e., measured hassles weekly). The sample consisted of 149 (69 females and 80 males) athletes from four sports, who completed the DHS to assess minor life events on a weekly basis, and their injuries were recorded as the number of injuries and severity of injury for each week following the DHS test. Fawkner found that athletes were more likely to incur an injury when they experienced significant increases in daily hassles in the week before and week of injury.

The third history of stressor variable hypothesised to influence the incidence of injury is previous injury history. There has been only one study examined this relationship. Hanson et al. (1992) found that the time duration since injury recovery was not related to severity or frequency of injury occurrence with 181 track and field athletes. To understand the true nature of this relationship, a variety of studies examining the possible association between previous injury history and the occurrence of injury need to be completed.

In summary, the relationship between life stress and sports injury proposed by Andersen and Williams (1988) has been supported by the literature. The strongest relationships between life stress measures and injury occur in contact sports like football (Blackwell & McCullagh, 1990; Bramwell et al., 1975; Coddington & Troxell, 1980; Passer & Seese, 1983; Petrie, 1993a, 1993b) and in high risk sports like gymnastics (Kerr & Minden, 1988; Petrie, 1992) and alpine skiing (May, Veach, Reed, & Griffey, 1985). In contact and high risk sports, the results have consistently shown that athletes with high life stress scores experienced greater injury occurrence than athletes with low stress scores. The frequent criticism of studies for using measures of life stress not designed for athletic populations and a range of injury measures makes the consistency of these findings even more impressive. Relationships between life stress and injury in non-contact sports, like volleyball (Williams et al., 1986) and cross country running (Williams, Haggert, Tonymon, & Wadsworth, 1986), have not been as strong. It was observed that a small sample size and relatively low level of stress limited any conclusions in another study (Andersen & Williams, 1988). Relationships between minor life events and injury have not been found with such regularity, because of methodological problems, primarily measuring daily hassles only once and then relating that measure to injuries for a period of 6 to 12 months. Future minor life events research should adopt the approach of Fawkner (1995), who conducted frequent measures of day-to-day problems, because daily stressors are constantly changing.

Personality research. The personalities of athletes may play a major role in how they respond to stressful sporting situations. Of the five personality factors proposed in the stress-injury model, there has been no athletic injury research measuring hardiness, sense of coherence, or achievement motivation. Jackson, Jarrett, Barley, Kausch, Swanson, and Powell (1978) examined the significance of trait factors for 110 high school football players, with Cattell's Sixteen Personality Factor Ouestionnaire (16-PF: Cattell, Eber, & Tatsuoka, 1974). Factor A, which is reserved versus outgoing, was negatively associated with injury severity. The more reserved, detached, critical, and cool players received injuries of higher severity than those players who were outgoing and warmhearted. Factor I was also negatively associated with injury severity and differentiated injured from non-injured players. This factor determines tough-minded versus tender-minded characteristics. The tender-minded players were more likely to report being injured than the tough-minded ones. In the six high school football teams studied, 50 players accounted for 70% of the multiple injuries. Examination of the seemingly accident prone players by the authors failed to produce any common personality profiles. Jackson et al. found that the 16-PF showed some potential for predicting injury, but argued that stronger relationships between predictor and criterion variables have to be established. Also, the limitation of this study is that there was no clear indication of how injury was measured or conceptualised.

Valliant (1981) investigated whether psychological, as well as physical and training factors, could differentiate injured and non-injured athletes. Form A of the 16-

PF was used to collect the psychological data. Valliant found that injured athletes were less tough-minded and less forthright than their non-injured counterparts. This finding was consistent with Jackson, et al. (1978). These data were collected retrospectively and included a vague definition of injury which was, physiological damage or bodily pain which interfered with one's ability to run. Injured runners were also found to be heavier, taller, and ran more miles per week than non-injured runners, suggesting that physiological training factors may also have contributed to the injury frequency rates of the runners studied. Another weakness of the Valliant study is its retrospective design. It can be assumed that retrospective studies do not have any predictive value, because of memory effect or recall problem. This study also reflected single variable data only. It is necessary to take into account the complex interaction of the many variables such as life stress, coping resources, and social support. Wittig and Schurr (1994) also examined the relationship between personality factors and incidence of injury. They found that tender-minded (i.e., dependent and over-protective) players were likely to be injured less often than the tough-minded (independent and self-confident) players. This result was contrary to the other 16 PF research (Jackson, et al., 1978; Valliant, 1981). Bearing in mind that the 16PF includes 16 factors, univariate significance for one or two factors in any study would be expected by chance. The repeated occurrence of the tough-minded trait would have been of some interest had the Wittig and Schurr finding not been opposite in direction to the others. General personality inventory research, as was found in the personality and sport behaviour area, might not be a fruitful approach. It is suggested that research targeted at specific personality variables might have greater potential.

Locus of control reflects the extent to which an individual perceives their life and environment to be under personal control. Dalhauser and Thomas (1979) examined the relationship between locus of control and athletic injury. They found that athletes who scored high on external locus of control had more severe injuries. A limitation of this study was that the measurement of injury did not report whether the research design was retrospective or prospective. Other researchers (Blackwell & McCullagh, 1990; Hanson et al., 1992, Kerr & Minden, 1988; McLeod & Kirkby, 1995; Passer & Seese, 1983), however, found no significant relationship between injury measures and locus of control. In general, there seems to be no established relationship between locus of control and the incidence of injury, but more studies are needed to confirm the relationship.

Self-concept has also been investigated in relation to injury outcome. Self-concept refers to a global perception of the self, and may include such factors as feelings about oneself and personal identity (Young & Cohen, 1979). Young and Cohen examined the relationship between self-concept, as measured by the Tennessee Self-Concept Scale, and injury occurrence, using female collegiate basketball players. They found that there was no significant difference in self-concept scores for injured and non-injured athletes. In a second study involving 190 female high school basketball players, Young and Cohen (1981) found that injured players had higher self-concept scores and scored more positively with respect to identity, health, skills, and personal worth, than non-injured players. The difference in the results of the two studies might have stemmed from experience associated with age and the different educational level of these women athletes. The college group might have gained more experience in coping with stressful situations. Young and Cohen concluded that athletes with higher self-concept expose themselves to greater risks and are therefore more likely to incur injuries. This idea gains some support from a study by Kerr and Minden (1988) that noted a trend toward significance, finding that gymnasts with higher self-concept scores on the Coopersmith Self-Esteem Inventory (Coopersmith, 1967), were more likely to become injured than players with a lower level of self-concept. Further research is warranted on the relationship between self-concept and sports injury. Use of sport specific self-concept measures might prove fruitful.

Greenberg (1983) described anxiety as a personality trait affecting one's perception of stress, which if high, can contribute to the manifesting of the negative, debilitating effects of stress. Spielberger (1989) also defined trait anxiety as an element of personality, where high trait anxiety predisposes an individual to perceive a wide range of objectively non-threatening circumstances as more threatening and more dangerous than do low trait anxious individuals. The effect of trait anxiety on the incidence of athletic injury has been examined (Blackwell & McCullagh, 1990; Hanson et al., 1992; Kerr & Minden, 1988; Passer & Seese, 1983; Petrie, 1993b). Blackwell and McCullagh (1990) measured the competitive trait anxiety of male college football players using the Sport Competition Anxiety Test (SCAT; Martens, 1977). Blackwell and McCullagh (1990) found that players who scored higher on sport competition trait anxiety were more likely to receive severe injuries than players who scored lower. Hanson et al. investigated the relationship between competitive trait anxiety and severity of injury occurrence in 181 track and field athletes using SCAT. They found that competitive trait anxiety was one variable that discriminated for severity of injury. Petrie (1993b) also examined the effect of competitive trait anxiety on incidence of injury using the SCAT. He found that competitive trait anxiety moderated the effects of positive life stress such that higher levels of anxiety and stress were associated with increases in the number of days missed due to injury.

Other researchers have not found a significant relationship between anxiety and injury. For example, the results of Passer and Seese (1983) showed that neither trait anxiety, measured by STAI, nor competitive trait anxiety measured by SCAT, consistently moderated the effects of the life stress-injury relationship in 104 college football players. Similarly, Kerr and Minden (1988) found no significant relationship of trait anxiety and the incidence of sports injury. The A-Trait scale of the STAI was used to measure the athletes' anxiety in the study of Kerr and Minden (1988). Unfortunately, except for Petrie (1993b), the preceding studies did not take into account whether personality factors might interact with life event stress or with coping resources in affecting injury risk. Williams and Andersen (in press) noted that such limited designs will not explain the potential role and complexity of the relationship of personality factors to injury risk.

In general, the attempts to examine the influence of personality factors on the incidence of sports injuries have produced equivocal results. For example, research using the 16-PF questionnaire, measures of locus of control, trait anxiety, and self-concept has produced inconsistent results. It appears that sport-specific inventories (i.e., athletically related measurement) might afford more useful findings than general inventories. The majority of the research has examined the direct effect of such personality variables on sports injury. It might be appropriate to investigate the potential moderating effects of personality variables on the life stress-injury relationship. Traits like personality hardiness and sense of coherence might act as buffers to the effects of a stressful environment, rather than as direct influences on the incidence of injury.

Coping resource research. Coping has been recognised as a critical factor in relation to stress in sport and exercise (Crocker & Gordon, 1986; Long, 1984; Mace & Card, 1989; Smith, 1980). Coping is defined by Lazarus and Folkman (1984) as "constantly changing and behavioral efforts to manage specific external and internal demands that are appraised as taxing or exceeding the resources of the person" (p. 141), and Tunks and Bellissimo (1988) defined coping by noting that "some individuals seem able to transform calamities into opportunities for growth while others transform everyday hassles into overwhelming adversities" (p. 171). So, coping responses are dynamic, conscious strategies that mediate between perceived major or minor life events and outcomes, such as positive and negative emotions, somatic complaints, and performance.

Coping skills can be categorised into three broad functional dimensions (Lazarus & Folkman, 1984): (a) the appraisal focus of coping attempts to understand and find meaning in a crisis, evaluating what is at stake and what coping resources are available; (b) problem-focused coping refers to cognitive and behavioural efforts used to change the problem causing the distress; these strategies include learning new skills and planning the specifics of how to solve or deal with the problem; and (c) emotion-focused coping involves strategies used to regulate emotional arousal and distress. These strategies include managing of feelings, denial, and relaxation. Social support may be viewed as a situational resource, and coping skills, such as cognitive, behavioural, and physiological resources, that either facilitate meeting the demands introduced by a stressor, as either problem-focused coping or emotion-focused coping (Lazarus & Folkman, 1984). Also, the perception of social support and coping skills as two independent, potential moderators of the life stress-injury relationship is based on the fact that personal and situational resources may be relatively independent of one another (Lazarus & Folkman, 1984).

The role of coping resources in injury risk was examined by Williams et al. (1986). They used the Stress Audit Questionnaire (Miller & Smith,1982). Participants were 179 (111 females and 68 males) college volleyball players. An open-ended question was added to the inventory, asking participants to list any additional activities they used as coping resources on a regular basis, including imagery, biofeedback, and other stress management techniques. Using a prospective design, where injuries were monitored throughout the season after coping was assessed, by the NAIRS, Williams et al. found that participants who had low coping resources were more likely to become injured. Blackwell and McCullagh (1990) used the same section of the Stress Audit Questionnaire. They found that athletes with a high number of coping resources were less likely to incur an injury than athletes with a lower number of coping resources. Smith, et al. (1990) examined the moderating influence of an athlete's psychological coping skills and social support on the effect of life stress on the incidence of injury. This study demonstrated a major methodological advance in design. The 451 athletes were males and females who participated in basketball, males who were involved in wrestling, and females from gymnastics. The social support measure was derived from one used previously by Cauce, Felner, and Primavera (1982). Social support was operationalised as the amount and quality of support available to the athlete from 20 different individuals (e.g., father, friend, coach) and groups (e.g., religious organizations, teammates). The psychological coping skills of the athletes were measured by the Athletic Coping Skills Inventory (ACSI; Smith et al., 1988). Smith et al., (1990) proposed

> a distinction between conjunctive moderation, in which multiple moderators must co-occur in a specific combination or pattern, in order to maximize the relation between a predictor and an outcome variable, and disjunctive moderation, in which any one of a number of moderators maximizes the predictor-criterion relation (p. 360).

Smith et al., (1990) found that psychological coping skills and social support interacted in a conjunctive manner, such that athletes who were low in both coping skills and social support, were more vulnerable to injury when life stress was high, but coping skills and social support individually did not directly affect injury occurrence. In contrast, for athletes who showed moderate or high scores in both coping skills and social support, disjunctive moderation led to a non-significant relationship between life stress and injury occurrence. These results suggest the need for future study in this area to be of a multivariate nature, and that the patterns of interaction of different variables are as important as examining the effect of each variable alone.

Social support is considered to be a situational coping resource in its own right. Petrie (1992) investigated the relationship between social support and sports injury in 103 female collegiate gymnasts, representing eight NCAA Division I-A teams. Petrie hypothesised that social support, as measured by the Social Support Questionnaire (SSQ; Sarason et al., 1983), would moderate the life stress-injury relationship. Petrie found that for gymnasts with low social support, negative life stress accounted for 11-22% of the variance in minor, severe, and total injuries, as well as total number of days missed due to an injury. In a subsequent study, Petrie (1993a) found similar results. Petrie investigated the moderating effects of social support, as measured by the Social Support Inventory (SSI; Brown et al., 1987) and playing status (i.e., starter vs non-starter) on the life stress-injury relationship in 98 collegiate football players. The results indicated that football starters with high negative life stress and low social support had an increased likelihood of suffering a severe injury, greater time loss, and more games missed due to injury but, no relationship emerged for non-starters. Recently, Andersen and Williams (1997) examined the effects of life stress, as measured by LESCA and social support, as measured by the SSQ, on injury outcome. They found that only negative life stress predicted incidence of injury, while their analysis indicated that, for athletes reporting low social support, injuries were predicted by negative life stress and peripheral narrowing. This is consistent with the work of Smith et al. (1990), which suggests that social support is a moderator of life stress, rather than a variable that mediates injury.

It appears that the importance of coping skills and social support for the prevention of injury in athletes has been widely supported (Blackwell & McCullagh, 1990; Petrie, 1992, 1993a; Smith et al., 1990). These factors might moderate the impact of negative life stress by decreasing the threat value of various life stressors (high social support), by helping to accurately interpret the events (cognitive appraisal), and by controlling arousal levels (coping skills). This might then moderate the attentional and performance deficits that have been suggested to mediate the stress-injury relationship. There is clearly a need for more studies that consider the moderating influences of personality and coping resource variables, in addition to any direct effects of stress responsivity and sports injury.

A substantial amount of psychosocial stress and athletic injury research has been conducted. To summarise this body of research, Table 2.1 illustrates the studies on psychosocial variables and sports injury for which relevant design and results details have been identified. In a review, Williams and Andersen (in press) identified 30 studies, 20 of which were reviewed previously by Williams and Roepke (1993). Williams and Andersen (in press) reported that approximately 27 of the 30 studies that measured life events found at least some significant relationship between life stress and injury.

Table 2.1

Research on Psychosocial Variables and Sports Injury

Study	Sample	Psychosocial Variables/Measures	Injury Measures	Findings	Comments
Andersen & Williams (1997)	196 NCAA Division I 10 sports athletes (79 males, 117 females)	life stress/LESCA social support/SSQ anxiety/STAI	number of injury events	LESCA Negative was associated with number of injury events. Also low SSQ combined LESCA negative associated with injury.	prospective
Blackwell & McCullagh (1990)	105 NCAA Division I football players	life stress/ALES daily hassles/DHS coping resources/SAQ anxiety/SCAT	Colorado Injury Reporting System (frequency, severity)	ALES Total, SCAT, and SAQ were associated with injury severity	prospective
Bond, Miller, & Chrisfield (1988)	33 elite Australian swimmers	attention/TAIS	injury status (intrinsic, extrinsic)	high TAIS score was associated with injury status	prospective
Bramwell et al. (1975)	82 NCAA Division I football players	life stress/SARRS	frequency	high SARRS score was associated frequency of injury	prospective
Byrd (1993)	113 Division I,II,III volleyball and basketball female collegiate athletes	life stress/LESCA daily hassles/DHS coping skills/ACSI social support/SSI attributional style/SASQ anxiety/SCAT	Colorado Injury Reporting System	LESCA Total, DHS, SCAT, ACSI, SSI , and SASQ associated with number of injury. SSI combined LESCA negative associated with injury.	prospective

Study	Sample	Psychosocial Variables/Measures	Injury Measures	Findings	Comments
Coddington & Troxell (1980)	114 high school football players	life stress/LES-A	NAIRS (severity)	high LES-A was associated with severity of injury	retrospective
Cryan & Alles (1983)	151 NCAA Division I football players	life stress/SARRS	frequency and severity	high SARRS was associated with severity and frequency of injury	retrospective
DeLongis et al. (1988)	75 married couple	daily hassles/HUS self-esteem/RS	Daily Health Record	HUS and low RS were associated health problem	prospective
Fawkner (1995)	149 football, hockey, volleyball, and triathlon athletes (80 males, 69 females)	life stress/ALES personality/16PF locus of control/IPC coping resources/WCC social support/SSQ6 daily hassles/DHS mood states (POMS)	frequency and severity	ALES Negative, IPC, WCC, SSQ6, and DHS were associated with severity and frequency of injury	prospective
Ford et al. (1997)	121 (65 males, 56 females) athletes from 6 sports	life stress/ALES social support/SSBS	time loss	ALES Negative and time loss were associated with high SSBS	prospective
Hanson et al. (1992)	181 NCAA Division I,Π track and field athletes (123 males, 58 females)	life stress/ALES daily hassles/EPS locus control/RLCS coping resources/SAQ anxiety/SCAT	Colorado Injury Reporting System (frequency, severity)	ALES Negative was associated with injury severity, and ALES Positive was associated with frequency of injury	prospective

Study	Sample	Psychosocial Variables/Measures	Injury Measures	Findings	Comments
Hardy et al. (1991)	170 NCAA Division I 7 sports athletes (78 males, 92 females)	life stress/ALES social support/SFQ	injury status, frequency, and severity	ALES total, negative, positive, and SFQ were associated with frequency of injury	prospective
Hardy & Riehl (1988)	86 NCAA Division I baseball, softball, tennis, and track males and females athletes	life stress/ALES	frequency and severity	ALES Negative was associated with injury	prospective
Holmes (1970)	100 NCAA Division I football players	life stress/SARRS	severity	high SARRS was associated with severity of injury	retrospective
Kerr & Minden (1988)	41 elite female gymnasts	life stress/CLER anxiety/STAI locus control/NSLCS self-esteem/CSEI	Gymnasts' Injury Questionnaire (number and severityof injury)	CLER Negative and CSEI were associated with the number and severity of injury	retrospective
Kolt & Kirkby (1994)	115 Australian elite gymnasts (32 males, 83 females)	anxiety/CSAI-2 mood/POMS-BI	incidence	CSAI-2 (cognitive anxiety) and POMS-BI (composed-anxious, energetic-tired) were associated with incidence of injury	prospective
Lysens et al. (1986)	99 university students (66 males, 33 females)	life stress/LEQ	incidence	high LEQ was associated with incidence of injury	prospective
Passer & Seese (1983)	104 NCAA Division I (55), Π (49) football players	life stress/ALES anxiety/STAI locus control/IELCS	time loss	ALES Negative was associated with time loss	prospective

Study	Sample	Psychosocial Variables/Measures	Injury Measures	Findings	Comments
Petrie (1992)	Study 1: 166 NCAA Division I-A,11 sports for men, 11sports for women. Study 2: 103 NCAA Division I-A female gymnasts	life stress/LESCA, SARRS social support/SSQ	time loss and severity	LESCA Negative and SSQ were associated with severity, time loss	prospective
Petrie (1993a)	98 NCAA Division I-A football players	life stress/LESCA social support/SSI	severity and time loss	LESCA Negative and SSI were associated with severity, time loss	prospective
Petrie (1993b)	158 NCAA Division I-A football players	life stress/LESCA coping skills/ACSI anxiety/SCAT-A	time loss	LESCA Positive, ACSI, and SCAT-A were associated with time loss	prospective
Smith et al. (1992)	425 high school athletes (boys' basketball, wrestling; girls' basketball, gymnastics)	life stress/APES sensation seeking/SSS coping skills/ACSI	time loss	APES Negative and SSS were associated with time loss	prospective
Smith et al. (1990)	451 high school athletes (boys' basketball, wrestling; girls' basketball, gymnastics)	major, minor life stress/APES social support/SS coping skills/ACSI	time loss	low in both SS, and ACSI were associated with APES Negative and time loss	prospective
Williams et al. (1986)	179 NCAA Division I volleyball players (68 males, 111 females)	life stress/ALES, SARRS coping resources/SAQ	NAIRS (severity, injury status)	SAQ was associated with injury status	prospective

Although recent research has been designed to better examine the relationship between life stress and sports injury, some problems still exist in this area of research. Firstly, the stress-injury research has used many different life-event scales. As Table 2.1 shows, these include SARRS, ALES, LES, LES-A, and LESCA, some of which have questionable reliability and validity for use with sports populations. For example, No reliability or validity data is provided for the SARRS. Secondly, Andersen and Williams (1988) indicated that more sport-specific assessment should be employed in stress-injury research, such as a locus of control instrument specific to sport. Thirdly, a limitation of some psychosocial studies is that they used retrospective injury reports, in that they asked participants to review past events involving memory of the specific details of each injury and their life stress during the same period. Kerr and Minden (1988) proposed that a prospective design would circumvent these problems by recording life events and injuries as they happen in time. The column to the right of Table 2.1 shows the retrospective and prospective design of each study. It is clear that recent research has more frequently employed prospective designs. Fourthly, a limitation of daily hassles studies is that athletes were only assessed on one occasion. Repeated measurement, such as that employed by Fawkner (1995), who assessed hassles on a weekly basis would better point out the effects of ever-changing minor life events. It could be that, for most people, daily hassles fluctuate over the period of time when injuries are monitored and incidence of injury fluctuates with extent of hassles. Finally, stress-injury research might attempt to measure psychosocial variables and injury outcome by the use of well-structured interviews as well as self-report scales, to take into account the meaning of, and effect of, psychosocial factors to the individual.

An example of this in a related area comes from a recent interview-based study of coping with retirement in elite footballers. Fortunato (1997) found that voluntary retirees, who coped well, valued and used social support that was offered by family and friends. Involuntary retirees (injured or deselected) did not feel able to accept social support from these sources, although it was offered, because they felt they had let their family and friends down. It should be noted that most of the measures used to assess social support in the research on psychosocial stress and sports injury access participants' perception of the amount and quality of social support.

Effect of Stress on Physiological/Attentional Changes

There has been little research examining the mechanisms proposed to explain how psychosocial factors influence the likelihood of injury. According to the Andersen and Williams model of stress and injury, physiological and attentional changes, particularly increased general muscle tension, narrowing of the visual field, and increased distractibility, that occur during the stress response in athletic situations, may influence injury outcome. It is important to demonstrate that stressful situations produce increased muscle tension and attentional disruptions, especially in high life stress individuals.

Only one study examined the relationship between psychosocial factors and physiological changes (i.e., increased general muscle tension) under low and high stress conditions (Andersen, 1988). Andersen found that the total group exhibited increased muscle tension during the stress condition. This study, however, failed to support the model's hypothesis that high risk individuals display greater muscle tension in stressful situation. The failure to do so might have resulted from involvement of the general population (university students) in the sample, rather than a high risk athlete population.

Changes in attention during stress have been documented (Easterbrook, 1959; Hancock, 1984; Kahneman, 1973; Nideffer, 1976b), however only a few studies have been conducted in a sport or sport-like setting (Andersen & Williams,1997; Williams & Andersen, 1997; Williams, Tonymon, & Andersen, 1990, 1991). Kahneman (1973) stated that as arousal increases, a progressive narrowing of cues takes place as well as the increased occurrence of attentional shifts to various stimuli. Thus, the possibility exits that many relevant stimuli will be excluded when arousal levels are too high. Nideffer (1976b) proposed that, as arousal level increases, attention narrows and then becomes focused internally, so that many cues in the environment, crucial to successful sport performance, are missed. He also proposed that individuals have preferred attentional styles. Nideffer (1976a) developed the Test of Attentional and Interpersonal Style (TAIS) to assess four attentional styles, as well as effective attentional functioning and self-reported overload.

Bergandi and Wittig (1988) examined whether the psychological variables of attentional style were related to the number of injuries sustained during an intercollegiate athletic season and tried to determine if the relationship varied with the type of sport. The participants were 335 athletes who were divided among 17 sports. The instrument used in the study was the TAIS. For this study, an injury was defined as any trauma requiring at least two treatments by the athletic training department. The TAIS was administered to each team as a group, prior to the start of their season. Three measures of effective attention were derived by comparing effective and overload scales for broad external, broad internal, and narrow aspects of attention. At the end of each season injury data were collected. Bergandi and Wittig found that prediction of injury through the three predictor variables was only significant for one sport, women's softball. Even though the TAIS only predicted significantly for one sport, it was able to explain 28% of the injury variance for men's basketball, 56% for women's volleyball, and 29% for women's gymnastics. Individuals in women's softball who scored high on the attentionally effective factor and low on the overload factor and the narrow aspects of attention were more apt to incur injury than those with other scoring combinations. This result is the reverse of what would be expected, if effective attention is an important factor in reducing the incidence of injury. A limitation of this study was that the power of statistical analysis was reduced because of the inability to combine several sports into a larger sample. It should also be noted that Bond, Miller, and Chrisfield (1988) have demonstrated that the TAIS is not a factorially sound instrument.

According to Smith et al. (1990), attentional disruptions may be produced by preoccupation with stressful events and their possible negative consequences. Such attentional disruptions include peripheral vision narrowing, often resulting in injury by not picking up or responding in time to vital or dangerous cues in the periphery. The attentional disruption proposition received some support from a study by Kerr and Minden (1988) in which the majority of female gymnasts reported 'lack of concentration' or 'thinking of other things' as major cause of their injuries.

Williams et al. (1990, 1991) conducted studies to examine the possible effects of stressful and non-stressful laboratory conditions on attentional mechanisms. Williams et al. (1990) hypothesised that recreational athletes with high life stress scores, as measured by the Life Experiences Survey (LES; Sarason et al., 1978), when placed in a stressful laboratory situation, would experience greater peripheral narrowing and an increase in state anxiety when compared to recreational athletes with low life stress scores. The participants were 32 recreational athletes, 15 males and 17 females, at the University of Arizona. In the stressful condition, participants performed a peripheral vision test and a Stroop Color Word Test (stressor). In the peripheral vision test, participants had their chin on a chin rest and focused on a central point, while a dot stimulus was moved in from the periphery. Participants were instructed to say the word "dot" at first sight of the stimulus. When the participant said dot, degrees from the point of focus were recorded to get a baseline for peripheral vision. A baseline of peripheral vision was perceived when earphones playing white noise were put on participants and then dots were randomly sent four times for each side and measurements in degrees were recorded. The Stroop Test consisted of six stimulus words of the names of various colours written in ink of a different colour on a scroll, for example "red" written in green ink. For the stress condition, each participant had to listen with earphones to a tape of distracting phrases, which were spoken at approximately the same pace that the colors were scrolled. As an incentive, a $20.00 award was to be given to the participant who answered the most Stroop stimuli correctly. Three two-minute trials of the stress condition were presented to each participant with a 20-second rest between the first and second trials. Random peripheral vision measures were taken for the three trials; five measures were taken in trials 1 and 3 and six measures were taken in trial 2. Sixteen measures were taken with eight on each side of the visual field. The eight trials for the right and left visual fields were averaged and then added together for a total visual field measure for the stress condition. Williams and her associates found that recreational athletes with high life stress scores experienced greater decrements in narrowing of their peripheral vision when placed in the stressful condition than recreational athletes with low life stress scores. The results of regression analysis indicated that negative life stress scores accounted for 19.7% of the variance in peripheral narrowing, while total life stress scores accounted for only 12.9%. As for state anxiety, only positive life stress scores were related to an increase in state anxiety.

In a second study, Williams et al. (1991) employed the same design, but also measured coping resources and minor life events. The participants were 74 university students, 44 males and 30 females, enrolled in physical activity classes at the University of Arizona. Williams et al. hypothesised that individuals with high self-reported stressful life events and daily hassles and low coping resources, when placed in a stressful laboratory situation, would experience greater peripheral narrowing and state anxiety than individuals with low stressful life events and daily hassles and high coping resources. Williams and her associates found that high levels of negative life stress and total life stress led to greater peripheral vision narrowing and high total life stress and daily hassles led to elevated state anxiety during the stress condition. Coping resources did not affect stress reactivity directly, but tended to moderate some of the history of stressor effects.

In a recent study, Williams and Andersen (1997) examined peripheral narrowing and disruptions in the central field (distractibility) of vision hypothesised in the Andersen and Williams (1988) model of stress and athletic injury. The sample was

201(81 males and 120 females) intercollegiate athletes from two NCAA Division I universities. Williams and Andersen hypothesised that athletes with high life stress, low social support, and low coping resources, when placed in a demanding situation, would have greater peripheral narrowing and central vision disruptions due to distractibility than those athletes with low life stress, high social support, and high coping resources. The Goldman Perimeter (See more detail in Harrington (1981)) measured peripheral and central vision during baseline and demanding task situations. The measures of peripheral and central vision deficits included delayed reaction time to targets, failing to detect targets, and lowering of perceptual sensitivity. Williams and Andersen found that performance under demanding task conditions lead to significant deterioration on all the perceptual variables. Athletes who had higher negative life stress scores experienced greater peripheral vision narrowing and slower central vision reaction time during stressful conditions, compared to athletes who had low life stress scores. In addition, males who had high scores on negative life stress, low social support, and low coping resources experienced the lowest perceptual sensitivity, and males who had low social support experienced more failures to detect central cues. Females who had high scores on negative life stress and low coping resources experienced more failures to detect central cues. A weakness of Williams and her associates (1990, 1991) studies is that they examined only attentional aspects. Andersen and Williams (1988) proposed that an elevated stress response in athletic situations, and physiological and attentional changes, may increase the risk of athletic injury. Therefore, it is necessary to test physiological changes, such as increased general muscle tension as well as attentional aspects, to better understand the responses of athletes under stress. Williams and her associates did not state intensity levels of either the white noise or the crowd noise used in their studies. This information would be helpful in interpretation and replication, because the effect of noise on stress varies with the intensity of the noise, as well as with its content (Pelmear, 1985).

None of these studies of the stress response examined the relationship of stress reactivity to injury outcome. In a recent study, however, Andersen and Williams (1997) examined visual perception, reaction time, and state anxiety during high and low stress conditions, and then recorded injuries for the entire season that followed. The participants were 196 (79 males and 117 females) collegiate athletes from two NCAA Division I universities. Andersen and Williams hypothesised that athletes with high life stress, low social support, greater perceptual change, greater anxiety, and slower reaction times during stressful conditions would be likely to incur more injuries than athletes with the opposite profile. Andersen and Williams found that, for the entire sample, only negative life stress significantly accounted for injury variance (19%), but for the low social support category of athletes, negative life stress combined with changes in peripheral narrowing accounted for 26% of the injury variance. This indicated that low social support athletes with more negative life stress and greater peripheral narrowing during stressful conditions incurred more injuries than those with the opposite profile. This study is the first to connect the proposed mechanisms underlying psychosocial factors to increased incidence of injury, as predicted by the Andersen and Williams (1988) model of stress and athletic injury.

These four experiments conducted by Andersen and Williams (1997) and Williams and her associates (1990, 1991, 1997) indicate that greater peripheral narrowing occurs in athletes who score high on negative life stress. These studies were conducted under controlled conditions in a laboratory environment. Clearly, sports are not conducted in this type of environment and the correlation between the laboratory and the sports ground has not been established, but the results are suggestions of what may be happening to visual attention on the playing fields with athletes who have high life stress and few moderating variables, especially from the coping resources category.

Stress Management and Injury Incidence

In the Andersen and Williams (1988) model of stress and athletic injury, it is predicted that the cognitive appraisal and the physiological/attentional aspects of the stress response may lead to injury, thus interventions aim to change the cognitive appraisal of potentially stressful events and to reduce the physiological/attentional aspects of the stress response. Few studies have prospectively tested the effects of interventions on the incidence of athletic injury.

Davis (1991) examined the effects of a stress management program on injury, using sport psychology programs. Davis hypothesised that sport psychology programs that trained athletes to relax would be associated with reduced incidence of injuries, and archival review of injury data would test this hypothesis. Davis conducted two studies for this purpose, one representing swimming (non-contact sport), and the second representing football (contact sport). The participants were 25 NCAA Division II program varsity swimmers and divers in the first study, and the Texas Christian University football team participated in the second study. Sport psychology programs involved progressive relaxation training and imagined rehearsal of sport skills, based on Suinn's (1982) Visuo-Motor Behaviour Rehearsal (VMBR) technique. Participants conducted relaxation training for 10 minutes and guided imagery of sport skills for five minutes after weekday afternoon practice. Injury data were collected by athletic trainers before, during, and after the two university teams practised progressive relaxation and guided imagery during team workouts. Davis found a 52% reduction in injuries for swimmers and a 33% reduction in injuries for football players when the incidence of injuries before the intervention was compared to that after the intervention. A limitation of this study was that it did not have a control group. It is important to employ a control group to account for placebo effects. Weinberg and Comar (1994) proposed that "without a placebo-control condition, then it becomes unclear whether it was the specific psychological intervention that produced the desired behavioural effects, or merely the fact that participants were being given special attention and believed that the intervention would be helpful" (p. 413).

A recent prospective injury prevention study, conducted by Kerr and Goss (1996), examined the effects of a long term stress management program on injuries and stress levels. The participants were 24 (8 females and 16 males) volunteer gymnasts who competed nationally and internationally. These gymnasts completed the Life Experience Survey (LES) to measure general life stress, and the Athletic Experiences Survey (AES) to assess athletic stress. Injury data were recorded by self-reported measures as injury occurred. This included information on the occurrence of injury and the number of days missed due to injury, and it was reported through biweekly conversations with the coaches. The participants were divided randomly into two groups, the experimental group which received the stress management program and the control group without exposure to the stress management program. A stress management program, based on Meichenbaum's (1985) stress inoculation training, was presented, including such skills as progressive relaxation, breathing, cognitive restructuring, thought control, imagery, and simulation. The experimenter met with each of the participants in the experimental group on a biweekly basis for eight months. Kerr and Goss found that during an eight month period, from mid-season (four months after pre-intervention measure) to peak season (four months from mid-season and held at the National Championship), the stress management group significantly reduced negative athletic stress and total negative stress, measured by the AES, and injury, compared to the control group. There was, however, no difference at mid season (after the first four months). A limitation of this study was the small number of participants in each group. Although there was no statistically significant results at mid season, the effect size for injury was substantial (i.e., Cohens' $d = .67$, which is in the high medium effect size range). The absence of significance was probably due to the small sample size and consequent low power. Another limitation of this study is that it is unclear how the injury incidence score was measured. Kerr and Goss stated that the value "incorporated both the number of injuries incurred and the duration of each injury" (p. 110), but how that 'incorporation' took place was not mentioned. They also did not include enough information on the development, validity, and reliability of the AES scale used to assess athletic stress.

The use of psychological interventions in the sport field, with the aim of reducing the occurrence of athletic injury has increasingly become a focus of applied work. Only a few studies have tested the effectiveness of these interventions in reducing the incidence of athletic injury. A principal reason for the lack of research in this area may be associated with the problems inherent in conducting such research. Problems include difficulty in controlling external validity (generalisability) and internal validity (cause and effect) and the problems of comparing different injuries. Successful intervention research is necessary to measure adequately the degree to which participants perceived that they were affected by different aspects of the stress management. Therefore, the need for manipulation checks in stress management research is crucial, given the subjective nature of individuals' response and perception of interventions.

The Present Thesis

The present thesis aimed to test parts of the Andersen and Williams (1988) model of stress and athletic injury. The first study in this thesis investigated the relationship between life stress and the incidence of sports injury in committed, but non-elite, contact sport competitors. The publication of a number of studies, more especially those with prospective designs, having established the life stress-injury relationship more firmly by the time that the first study was completed, it was decided that it would be more appropriate to focus the thesis on the mechanisms by which stress and life stress affect sports injury. The second study, thus, focused more narrowly on the effects of life stress and coping resources on central and peripheral visual attention in stressful conditions. None of the research examined in the literature has tested the effectiveness of stress management interventions aimed at modifying stress levels in terms of the effects of the interventions on central and peripheral visual attention. In the third study in this thesis, the efficacy of a stress management program using Autogenic Training (AT) for reducing the anxiety response to a stressful laboratory situation, was examined, and the effect of the this program on visual attention under stress was observed.

Chapter 3: A Test of the Relationship between Life Stress and Sports Injury

Introduction

Many injuries occur as a result of participation in sports and recreation. In the United States, researchers have estimated that of eight million students who participate in high school sports, two million students will be injured each year (Smith, 1996). Australian Sports Commission (1993) reported that 1 in 17 Australians suffer some type of sport injury each year at a total health cost to the community of about $1 billion. These injuries can carry with them considerable emotional and financial costs, create chronic physical problems, disrupt competitive athletic seasons, and alter daily functioning.

Past research has examined physical factors, such as lack of training and over-training, environmental factors, such as weather and field or playing surface conditions, and equipment problems, such as inappropriate studs or spikes and absence of protective headgear, that may predispose one to injury (Heil, 1993). In spite of the technological advances, such as improved athletic equipment, creation of safer playing facilities and surfaces, education of players and coaches in observance of safety rules and safe playing behaviour, advanced teaching and coaching techniques, development of scientific conditioning programs, and the certification of trainers for sports programs, athletic injuries continue to rise in most sports (Crossman, 1997). Physical and environmental factors do not adequately explain athletic injury variance. Therefore, examination of other factors contributing to sports injuries seems warranted. Psychological factors such as the effects of life stress on injury outcome, have received increased attention. For example, a model of stress and athletic injury (Andersen & Williams, 1988) offers a comprehensive framework for the study of the relationship between psychosocial factors, stress, and injury and suggests specific interventions for reducing the risk of athletic injury. Andersen and Williams' model proposes that a person's history of stressors (e.g., life events, daily hassles), personality (e.g., hardiness, competitive trait anxiety), coping resources (e.g., social support system, stress management, and mental skills) may have an influence on the magnitude of the stress response when an athlete is in a stressful situation. Andersen and Williams (1997) examined the life stress and injury relationship. They found that negative life events during stress were an important predictor of the number of injuries.

The present study also investigated the relationship between life stress and gender. Hardy, Richman, and Rosenfeld (1991) reported that "high-stressed males and low-stressed females reported receiving higher amounts of technical appreciation support from their coaches than did the other athletes, and low-stressed females reported receiving more listening support from their friends than the other athletes" (p. 130). Hardy and Riehl (1988) also found that the relationship between life stress and the frequency of injury was significant for female athletes, with total life stress being the most important predictor. Therefore, it is expected that female athletes will show a stronger relationship between life stress and injury rate than male athletes.

Although research to refine understanding of the role and function of psychological factors in sports injuries continues, at the time when this study was conducted, the evidence to conclude that psychosocial factors influence injury risk was still equivocal. The present study was designed to investigate the relationship of life stress to athletic injury, as well as to gather injury data on the principal body part injured, the type of injury, and the number of days missed. It thereby tested a central part of the model of psychological antecedents of sports injuries proposed by Andersen and Williams (1988).

Research Hypotheses

The research hypotheses are stated in the experimental form. All testing is at the $p < .05$ significance level.

1. Athletes with negative life stress incur significantly more injuries than athletes with positive life stress.
2. Athletes with negative life stress have significantly more missed days of practice and competition due to injury than athletes with positive life stress.
3. Female athletes have a stronger relationship between negative life stress and incidence of injury and missed days of practice or competition due to injury than male athletes.

Method

Participants

The participants for this study were 320 competitive athletes (234 males, 86 females) ranging in age from 17 to 35 ($M = 23.4$). All participants were involved in selected competitive contact team sports in Melbourne clubs. The sports were football, field hockey, soccer, judo, taekwando, and lacrosse. The number of participants in each sport by gender are shown in Table 3.1. Sports that are considered to have high injury risk were selected for this study, being either contact team sports or martial arts activities. All participants participated in regular training under the guidance of a coach and competed in an organised competition (i.e., regional, league, provincial, or local). All participants were volunteers and completed a standard consent form (see Appendix A).

Table 3.1

Gender and Sport Distributions of the Participants

	Football	Hockey	Judo	Soccer	Taekwando	Lacrosse	Total
Male	72	42	22	29	35	34	234
Female	0	20	16	25	17	8	86
Total	72	62	38	54	52	42	320

Measures

Athletic Life Experience Survey (ALES; Passer & Seese, 1983). The ALES measures athletes' life stress. Although there is some criticism of the ALES (see page 40), the ALES has proved successful in past research for identifying athletes at increased risk of injury (e.g., Blackwell & McCullagh, 1990). As it appeared to be the most widely used measure in the literature, it was decided to use the ALES for the purposes of comparison. ALES is a 70-item inventory with items such as personal changes, family, job, and team problems. Participants checked whether they had experienced such a stressor during the past 12 months and, if they had, reported its impact. Each life event was scored by the participants on a scale from +3 (Good) to -3 (Bad). A score of 0 indicates that the event occurred but had no perceived positive or negative effect. To score the ALES, three separate scores are obtained. One score is derived by summing all the items that reflect negative life events, as rated by that individual, while a second score results from adding up all the items that were assessed as positive life-events. A total life stress score can also be derived by summing all the items, but only the positive and negative scores were used in the present study. A five week test-retest reliability was, r = .66, in an independent sample of 32 physical education students (Passer & Seese, 1983).

Injury Surveillance System (ISS; National Collegiate Athletic Association, 1991-1992). The Injury Surveillance System (ISS) is the National Collegiate Athletic Association (NCAA) Injury Surveillance System. This questionnaire includes questions relating to number of days missed due to injury, principal body part injured (e.g., head, shoulder, knee, ankle), primary type of injury (e.g., abrasion, sprain, strain, overuse), and cause of injury. The participants were asked to report any injuries that occurred in the previous year.

Procedure

First, a letter was sent to the presidents of the clubs of the participating sports. This had two purposes: (a) to obtain permission from each club to use their players in the research, and (b) to arrange a time for administration of the questionnaire. After permission was granted, I visited clubs to survey the status and history of participants' injuries, the number of days of training and competition missed because of injury, the body part injured, and their experience of life stress. Information on injury and life event stress was obtained by administering the Injury Surveillance System (ISS) and the Athletic Life Experience Survey (ALES) respectively and in that order. The number of missed days was used as the basis of a classification of the injuries as minor, moderate, and major. A minor injury was defined as one where the injured player returned to play within 1 to 2 days. Moderate injury was defined as the player being out of action between 3 to 9 days. Severe injury was defined as occurring when a player was sidelined for 10 days or longer. Before any testing commenced, each participant was informed of the nature of the research, that their data would be confidential, and that they were free to withdraw at any time. Then they completed a standard consent form.

The instructions in the questionnaires requested that the participant self-report any life events or injuries that had occurred in the past 12 months. The participant completed these questionnaires after they had finished a training session. All participants were volunteers. They completed the questionnaires in the club-house under my supervision and that of their coach. All participants completed the Injury Surveillance System (ISS) and the Athletic Life Experience Survey (ALES). About 15 minutes was needed to complete both questionnaires. Then they were debriefed and thanked for their participation.

Results

Injury Statistics

Of the 320 athletes in this study, 191 (59.7%) experienced injuries, and 129 (40.3%) remained free from injury. Of the 135 males, 57.6% were injured; of the 56 females, 65.1% were injured. Of the 191 athletes who reported injuries, 54 (28.2%) were classified as having minor injuries, 76 (39.7%) as having moderate injuries and 61 (31.9%) as having major injuries, in terms of days they missed training and competition.

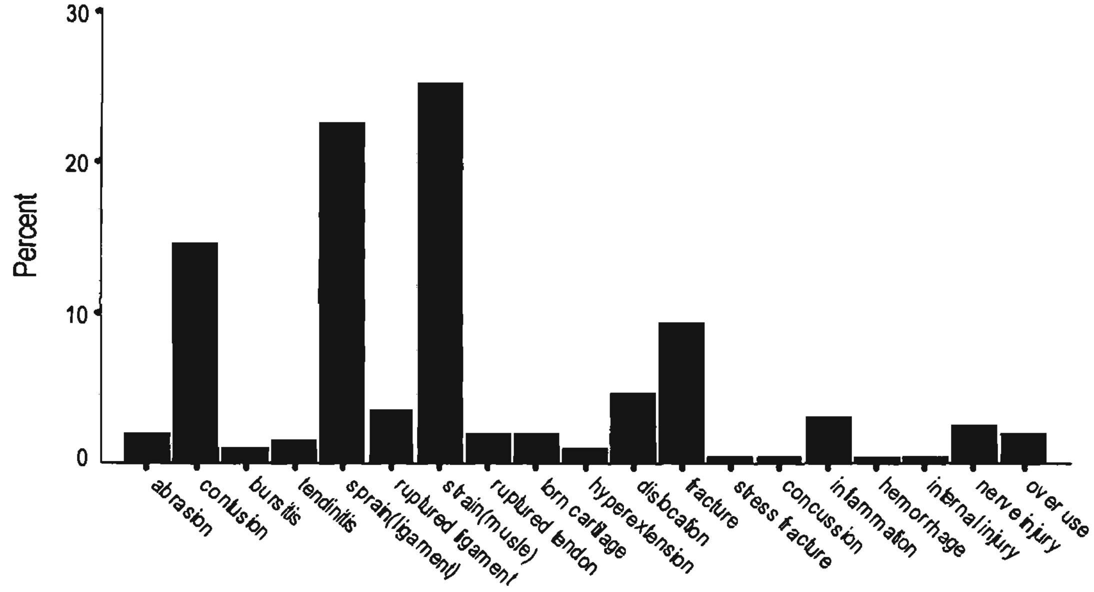


Figure 3.1. Type of injury

The most frequent injury was muscle strain (25.1%), followed by ligament sprain (22.5%), contusion (14.7%) and fracture (9.4%). This is illustrated in Figure 3.1.

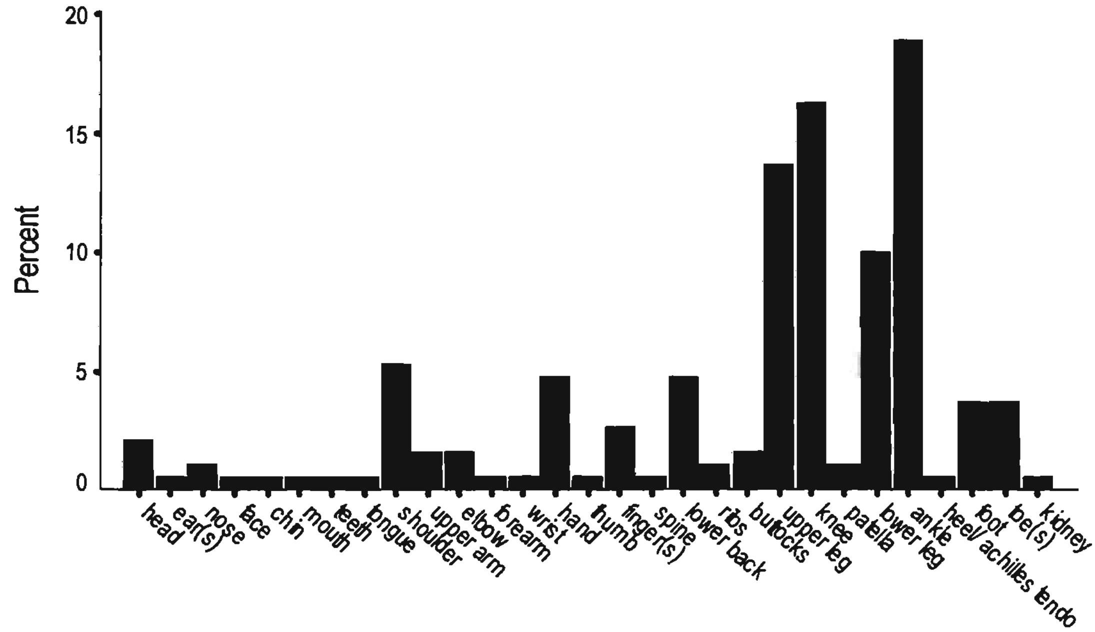


Figure 3.2. Areas of injury

The most frequently injured areas were ankles (18.9%), knees (16.3%), upper legs (13.7%), and lower legs (10.0%). These results are depicted in Figure 3.2.

Life Stress

The mean scores and standard deviations for injured and non-injured athletes for males and females on the ALES Positive, and ALES Negative are shown in Table 3.2, and the means and standard deviations for positive and negative ALES scales for number of missed days due to injury are shown in Table 3.3. The results comparing mean scores on the questionnaires, indicate that there is a clearer difference between injury and non-injury for females on all scales, whereas the males reported higher life stress mean scores than the females.

Table 3.2.

Mean Scores and Standard Deviations for ALES for Non-injured and Injured Players (N = 320)

		ALES			
Injury Status		Positive		Negative	
	n	M	SD	M	SD
Non-injured					
Male	99	11.7	11.1	9.4	11.1
Female	30	9.2	9.1	7.2	11.1
Combined	129	11.1	10.7	8.2	10.2
Injured					
Male	135	10.2	9.5	11.9	10.1
Female	56	10.3	10.3	11.2	11.6
Combined	191	10.2	9.7	11.7	10.5

To test the hypotheses that athletes with negative life stress would incur more injuries than athletes with positive life stress, and that there would be gender differences between psychological variables and injuries, a two-way Multivariate Analysis of Variance (MANOVA), with two independent groups factors, injury, with two levels (injury/non-injury), and gender with two levels (male/female), was performed with the ALES positive and negative scales as dependent variables. The analysis showed a main effect for injury status on the ALES Negative scale, $F(1, 316) = 7.28$, $p < .007$. Examination of the means indicated that injured athletes scored higher than uninjured athletes on the ALES Negative scale. There was no significant main effect for gender, and the gender by injury interaction was not significant for either of the ALES scales.

Table 3.3.

Means and Standard Deviations for ALES for Number of Missed Days (N = 320)

Injury Status	n (m/f)	ALES Positive M	SD	ALES Negative M	SD
Missed days					
0 day	129 (99/30)	11.1	10.7	8.7	10.2
1-2 days	54 (32/22)	9.6	9.2	9.9	8.4
3-9 days	76 (49/27)	12.1	10.5	13.4	12.2
10 or more days	61 (54/7)	8.3	8.2	11.0	9.7

To test the hypotheses that athletes with negative life stress incur significantly more missed days than athletes with positive life stress, and that there are gender differences in number of missed days, a two-way MANOVA was run on the ALES positive and negative scales with gender (male/female) and days missed with four levels (0 day, 1-2 days, 3-9 days, and 10 or more days), as the two independent groups factors. The analysis showed that the main effect of number of days missed was statistically significant for the ALES Negative scale, F (3, 312) = 4.74, $p < .003$. Athletes who scored higher on the ALES Negative scale were more likely to have more days missed due to injury than athletes who scored lower. Newman-Keuls post hoc tests indicated that the main effect of number of days missed was significant ($p < .05$) between the 3-9 days group and the 0 days, that is no injury, group. Gender was not found to be significant for the two ALES scales, and the gender by severity interaction was also not significant for the ALES scale scores. The effect sizes of η^2 ("eta" squared) were small for injury status (.02), and small-medium for days missed (.04).

Discussion

The purpose of this study was to investigate the relationship between life stress and athletic injury, as well as to gather injury data, on the type of injury and the number of days missed from training and competition due to injury. In this study, 59.7 % of a sample of more than 300 participants in six contact sports experienced at least one injury over the year. This indicated that a high proportion of players had been injured. This study, also, found that the most common type of injury was muscle strain, followed by ligament sprain, contusion and fracture, and the most common location of injury was ankles, followed by knees, upper legs and lower legs. Barker, Beynnon, and Renstrom (1997) reported that 10 to 28 % of all athletic injuries were ankle sprains. They also noted that "in athletes, the lateral ankle complex has been deemed the most frequently injured single structure in the body" (p. 69).

The results of the present investigation are consistent with past research that has shown a relationship between life stress and the occurrence of athletic injury (Andersen & Williams, 1997; Blackwell & McCullagh, 1990; Cryan & Alles, 1983; Hardy, Richman, & Rosenfeld, 1991; Passer & Seese, 1983; Smith, Smoll, & Ptacek, 1990; Summers, Fawkner, & McMurray, 1993; Thompson & Morris, 1994). The hypothesis that athletes with negative life stress would be more likely to be injured than athletes with positive life stress was supported. This study found that injured athletes had higher ALES negative scores than athletes who were not injured. There were no gender differences. The hypothesis that athletes with negative life stress incur significantly more missed days than athletes with positive life stress was supported. This study found that athletes in the more days missed groups had higher negative life stress than those in the few days missed groups, but the only significant difference occurred between the 3 to 9 days missed and the 0 days missed groups. The 10 or more days missed group included only a small number of females. At the same time, there was no significant interaction of gender and injury severity.

This study was retrospective in its design. The weaknesses of the retrospective design have been noted by Hanson, McCullagh, and Tonymon (1992). There are not just memory effects (i.e., athletes forget about their injuries), but recall is also affected by events, so injury during the previous year could cause the athlete to report greater levels of stress during that period. A limitation of this study was that athletes were only assessed on one occasion. Repeated measurement would better point out the effects of ever-changing life events. Future research needs to determine the optimal tools for measurement of life stress as well as repeated measurements of more transient aspects of psychological variables related to the stress of daily living. Studies by Thompson and Morris (1994) and Petrie (1993b), which have employed a more robust prospective design, measuring life stress and then monitoring injuries, have supported the life stress-injury relationship.

The major finding from the present study is that those athletes (competitive contact team sports) who were injured in the past year reported more negative life stress than athletes who were not injured. These results provide support for the Andersen and Williams (1988) model of stress and athletic injury, which proposes that a person's history of stressors, such as life events and previous injuries, may have an influence on injury outcome. This study, also, found that those who had missed 3 to 9 days of training had significantly higher negative life stress than the group with no days of missed training. The results indicated that negative life stress was a noteworthy factor related to number of days missed, although it was noteworthy that the life stress level for those who missed 10 days or more was not as high as that for the 3 to 9 days missed group. This suggests that the results are not simply an artefact of the retrospective design. If they were, it would be expected that 10 or more days injured would have produced a higher level of life stress than 3 to 9 days missed due to injury.

The recent research using both retrospective and prospective designs (Andersen & Williams, 1997) has demonstrated that life stress, and stress in general are related to the incidence of injury in sport. To understand the stress and injury relationship better, the priority must be to study the mechanisms underlying the stress and injury relationship. Future research should attempt to verify the mechanisms proposed in the stress and athletic injury model (Andersen & Williams, 1988). Andersen and Williams have suggested that muscle tension and attentional disruptions (narrowing of the visual field and increased distractibility) are processes that put an individual at greater risk for athletic injury. Future research should, thus, examine the effects of stress and life-stress on attention and muscle tension, to increase understanding of those mechanisms in the stress-injury process. Also, Andersen and Williams suggested that interventions for reducing the effects of stressors, minimising attentional deficits, and counteracting physiological aspects of the stress response (e.g., autogenics, meditation, and relaxation skills) will reduce the incidence of athletic injury. Future researchers should examine the effects of stress management programs in the management of life stress, and research should monitor attentional and physiological changes associated with the stress response, when such interventions are used.

Chapter 4: Stress, Life Stress, and Visual Attention

Introduction

The first study in this thesis supported other research that has shown a relationship between stress, specifically life events and athletic injury, as proposed by Andersen and Williams (1988). Other retrospective studies of stress and injury (e.g., Cryan & Alles, 1983; Kerr & Minden, 1988) and, more recently and more convincingly, prospective studies, where stress is measured and then injuries that ensue are recorded (e.g., Fawkner, 1993; Ford, Eklund, & Gordon, 1997; Hanson, McCullagh, & Tonymon, 1992; Hardy, Richman, & Rosenfeld, 1991; Smith, Smoll, & Ptacek, 1990; Petrie, 1992, 1993a, 1993b; Thompson & Morris, 1994) now provide substantial support for the stress-injury relationship. A further test of the Andersen and Williams model would be to examine the mechanisms proposed to explain why the likelihood of injury is increased when stress is high.

The Andersen and Williams (1988) model of stress and athletic injury suggested that an elevated stress response in athletic situations, and particularly, the accompanying muscle tension and attentional disruptions (narrowing of the visual field and increased distractibility), increase the risk of athletic injury. They hypothesised that individuals with high life events and many daily hassles when placed in stressful situations may experience a larger stress response, reflected in greater peripheral narrowing and increased distractibility.

The moderator variables of social support and coping resources have been recognised as critical factors in the stress relationship in sport and exercise (Andersen

& Williams, 1988; Smith et al., 1990; Petrie, 1993a). The role of coping resources in injury risk was also described by Williams, Tonymon, and Wadsworth (1986). They found that athletes who had low coping resources were more likely to become injured.

Many physiological responses that might affect injury incidence occur during stress, but perceptual changes, in the form of attentional disruptions, such as narrowing of the visual field and increased distractibility, may be the changes most closely connected to injury risk (Andersen & Williams, 1988, 1997; Williams et al., 1990, 1991). For example, according to Kerr and Minden (1988), the majority of elite female gymnasts in their study reported "lack of concentration" or "thinking of other things" as the most commonly given cause of their injuries. Also, Nideffer (1983) pointed out that narrowing of attention due to increased stress has a detrimental effect on performance, particularly in the case of open skills, such as those that occur in complex and rapidly changing situations. Under stressful conditions, it has been found that individuals with high levels of life-event stress experience greater narrowing of peripheral vision than individuals with low levels of life-event stress (Williams & Andersen, 1997; Williams et al., 1990, 1991). This narrowing of the visual field could make it difficult for the athlete to pick up cues in the periphery, or lead to the performer reacting more slowly to such cues under stressful conditions. Magill (1985), in a related study of visual attention, reported that reaction time to peripheral targets increased as the distance of the stimulus from focal vision increased. Martens (1971) and Landers (1980) have argued that peripheral narrowing could act in opposite directions under some circumstances, based on Easterbrook's

& Williams, 1988; Smith et al., 1990; Petrie, 1993a). The role of coping resources in injury risk was also described by Williams, Tonymon, and Wadsworth (1986). They found that athletes who had low coping resources were more likely to become injured.

Many physiological responses that might affect injury incidence occur during stress, but perceptual changes, in the form of attentional disruptions, such as narrowing of the visual field and increased distractibility, may be the changes most closely connected to injury risk (Andersen & Williams, 1988, 1997; Williams et al., 1990, 1991). For example, according to Kerr and Minden (1988), the majority of elite female gymnasts in their study reported "lack of concentration" or "thinking of other things" as the most commonly given cause of their injuries. Also, Nideffer (1983) pointed out that narrowing of attention due to increased stress has a detrimental effect on performance, particularly in the case of open skills, such as those that occur in complex and rapidly changing situations. Under stressful conditions, it has been found that individuals with high levels of life-event stress experience greater narrowing of peripheral vision than individuals with low levels of life-event stress (Williams & Andersen, 1997; Williams et al., 1990, 1991). This narrowing of the visual field could make it difficult for the athlete to pick up cues in the periphery, or lead to the performer reacting more slowly to such cues under stressful conditions. Magill (1985), in a related study of visual attention, reported that reaction time to peripheral targets increased as the distance of the stimulus from focal vision increased. Martens (1971) and Landers (1980) have argued that peripheral narrowing could act in opposite directions under some circumstances, based on Easterbrook's

& Williams, 1988; Smith et al., 1990; Petrie, 1993a). The role of coping resources in injury risk was also described by Williams, Tonymon, and Wadsworth (1986). They found that athletes who had low coping resources were more likely to become injured.

Many physiological responses that might affect injury incidence occur during stress, but perceptual changes, in the form of attentional disruptions, such as narrowing of the visual field and increased distractibility, may be the changes most closely connected to injury risk (Andersen & Williams, 1988, 1997; Williams et al., 1990, 1991). For example, according to Kerr and Minden (1988), the majority of elite female gymnasts in their study reported "lack of concentration" or "thinking of other things" as the most commonly given cause of their injuries. Also, Nideffer (1983) pointed out that narrowing of attention due to increased stress has a detrimental effect on performance, particularly in the case of open skills, such as those that occur in complex and rapidly changing situations. Under stressful conditions, it has been found that individuals with high levels of life-event stress experience greater narrowing of peripheral vision than individuals with low levels of life-event stress (Williams & Andersen, 1997; Williams et al., 1990, 1991). This narrowing of the visual field could make it difficult for the athlete to pick up cues in the periphery, or lead to the performer reacting more slowly to such cues under stressful conditions. Magill (1985), in a related study of visual attention, reported that reaction time to peripheral targets increased as the distance of the stimulus from focal vision increased. Martens (1971) and Landers (1980) have argued that peripheral narrowing could act in opposite directions under some circumstances, based on Easterbrook's

(1959) cue utilisation theory. For instance, when a performer needs to attend to a limited range of cues, while there are many other things going on that could distract them, peripheral narrowing could narrow attention onto the task relevant cues, thus enhancing performance. Frequently, however, such narrowing becomes so focused that important cues are missed. In addition, narrowing of attention onto cues central for task performance under stress could mean that less attention is paid to those peripheral cues that relate to injury (e.g., tacklers approaching from the side).

In order to study effects of stress on performance in visual tasks, it is necessary to impose stressors in a controlled way. There are many psychological stressors. One that is widely researched and easy to impose, is noise. Noise is also commonly a part of the sport environment, especially at the elite level. Selye (1976) reported that noise acts essentially as do other stressors. The hormonal changes seen in humans under stressful noise conditions are the same as those brought out by other stressors. Kryster (1970) explained various physiological reactions to auditory stimuli, which he labelled the "N-Response". The reactions include: (a) a blood circulatory response dominated by vasoconstriction of the peripheral vessels with other adjustments of blood pressure throughout the body, minor changes in heart rate, and an increase blood flow to the brain whose blood vessels show no constriction with such stimulation; (b) increased galvanic skin response; and (c) a brief change in skeletal muscle tension. He found that a white noise level of 70 dB begins to elicit peripheral vasoconstriction and a decreased stroke volume, during a study of the effects of auditory stimuli upon physiological function. Many experiments have confirmed that noise stress does not only affect human performance, but also

Physical activity is a part of most sports. The stress of physical activity involves a change in physiological and biochemical processes in the body, such as increased blood pressure, muscle tone, rate of respiration, heart rate, and sweating, while it also stimulates blood flow, enhancing oxygen transfer to the various tissues and organs of the body (Hockey, 1983). Physical activity has extreme effects on the various systems of the body, depending on how strenuous the activity is.

The purpose of this study was to examine central and peripheral attentional processing during situations varying in objective physical and psychological stress for individuals with ranging levels of life-event stress, coping skills, and social support. This experiment aimed to test part of the Andersen and Williams model (1988) of life stress and injury. Specifically, it aimed to examine the effects of stress on visual attention reaction time within a laboratory setting.

Research Propositions

The research propositions stated here are based on the Andersen and Williams model and previous research on stress and attention. All testing is at the $p < .05$ significance level.

Central Task

1. Participants during the physical activity and noise conditions have significantly greater errors in detection and longer response times to central targets than when they are in the baseline condition.

2. Life stress, coping skills, and social support are significantly related to errors in detection and response times to central targets.

Peripheral Task.

1. Participants in the physical activity and noise conditions have significantly greater errors in detection and longer response times to peripheral targets than when they are in the baseline condition.

2. Life stress, coping skills, and social support are significantly related to errors in detection and response times to peripheral targets.

Peripheral Angle

1. Participants have significantly greater peripheral detection errors and longer response time as the peripheral angle increases.

2. Participants in the physical activity and noise conditions have significantly greater increases in peripheral errors in detection and longer response times as the peripheral angle increases than when they are in the baseline condition.

Method

Participants

The participants were 20 physical education students from the Victoria University of Technology (10 males, 10 females) ranging in age from 18 to 25 (M = 22). All participants took part regularly in at least one competitive sport activity for a minimum of 5 hours per week. All participants were volunteers and they completed a standard consent form (see Appendix B).

Research Design

The experiment consisted of four conditions: baseline, noise, physical activity, and physical activity/noise. These were presented in balanced order, as shown in Figure 4.1. Each order involved five participants. Before proceeding with testing central and peripheral vision in these conditions, all participants completed the Athletic Life Experience Survey (ALES), Athletic Coping Skills Inventory (ACSI), and Social Support Questionnaire (SSQ), and then performed the Physical Working Capacity $(PWC)_{170}$ test. Participants sat on a bicycle ergometer wearing headphones, which only functioned in the 95 decibel (dB) noise conditions. They only pedalled the bicycle in the physical activity and physical activity/noise conditions, maintaining the work rate determined by the PWC test. In each condition, they responded to 72 stimuli on the central task and 48 stimuli on the peripheral task, where presentation left and right visual fields were balanced. The number of stimuli from each peripheral angle was also balanced. After each condition, the participants had two minutes break.

<table>
<tr><th>Order</th><th colspan="2"></th><th colspan="4">Condition</th></tr>
<tr><td>1
(5 participants)</td><td rowspan="4">complete questionnaires

(ALES, ACSI, SSQ,)</td><td rowspan="4">PWC_{170}

test</td><td>baseline</td><td>noise</td><td>physical activity</td><td>physical activity /noise</td></tr>
<tr><td>2
(5 participants)</td><td>physical activity /noise</td><td>physical activity</td><td>noise</td><td>baseline</td></tr>
<tr><td>3
(5 participants)</td><td>noise</td><td>physical activity /noise</td><td>baseline</td><td>physical activity</td></tr>
<tr><td>4
(5 participants)</td><td>physical activity</td><td>baseline</td><td>physical activity /noise</td><td>noise</td></tr>
</table>

Figure 4.1. Research design including four balanced orders

Measures

Athletic Life Experience Survey (ALES; Passer & Seese, 1983). The same ALES inventory was used as described in the Method section of Study 1 in this thesis (see Chapter 3).

Athletic Coping Skills Inventory (ACSI; Smith, Smoll, & Schutz, 1988). The ACSI measures psychological coping skills. The ACSI consists of 42 behavioural self-report items designed to measure a range of general coping skills within a sporting environment. The following are sample items: "I can focus my attention narrowly and block out distractions," and "My emotions keep me from performing at my best." Each item is scored on a 4-point Likert type scale ranging from 0 (almost never) to 3 (almost always). Total scores on the scale can range from 0 to 126. Smith, Smoll, and Schutz reported test-retest reliability of .88, and a Cronbach's alpha coefficient of .90.

Social Support Questionnaire 6 (SSQ-6; Sarason, Sarason, Shearin, & Pierce,1987). The SSQ-6 was derived from the 27 item Social Support Questionnaire (SSQ; Sarason, Levine, Basham, & Sarason, 1983). Each of the six items has two parts. The first part of each item assessed the number of available others the respondent believed they could depend upon for each type of support. The six types of social support were “distraction from worries”, “total acceptance”, “assistance with relaxation”, “elevation of mood”, “provision of care”, and “personal consolation”. The second part of each item measures the individual’s degree of satisfaction (satisfaction score). The responses to the satisfaction component have a 6-point Likert scale ranging from 1 (very dissatisfied) to 6 (very satisfied). The total

SSQN score is obtained by summing the number of individuals providing support across 6 items and total SSQS scores are obtained by summing the ratings across all the items. Internal consistency (Cronbach's alpha) has been reported by Sarason et al. to be .90 for the SSQN and .93 for the SSQS.

The Physical Working Capacity $(PWC)_{170}$ Test (Astrand & Rodahl, 1977). Participants completed a workload test prior to the visual attention task to determine each participant's capacity, because every individual has a different maximal workload. The workload test used was the Physical Working Capacity $(PWC)_{170}$ test on a bicycle ergometer. PWC is defined as the maximum level of work of which an individual is capable, and the PWC_{170} test is a valid method of predicting this level from submaximal heart rate measures (Astrand & Rodahl, 1977). The PWC_{170} test estimates the maximum level of work of an individual by having the individual work at two separate submaximal workloads and obtaining a heart rate measure at each workload. These two points are recorded on a graph and a straight line is drawn between the two (Mathews & Fox, 1976). This line is extrapolated to a point on the graph corresponding to a heart rate of 170 beats per minute (bpm). A specific percentage workload can be ascertained by calculating the proportion of the maximal workload that corresponds to that percentage.

Apparatus

Monark bicycle ergometer. In order to imitate stress conditions in sport, which usually involves physical stress, the physical stress was simulated on a bicycle ergometer. The bicycle ergometer is more suitable for the study of visual attention than either the treadmill or actual running, because most participants are familiar with riding a bicycle whereas a treadmill might be unfamiliar and awkard for some (Astrand & Rodahl, 1977). Also, it is necessary to maintain the head in a fixed position for the peripheral vision tests, but the head moves up and down during running. In this study, a workload was selected corresponding to approximately 40% of maximum. This was selected because, during pilot work, a workload greater than 40% of maximum was found to be too difficult for participants to maintain, while still performing the visual attention task at a meaningful level.

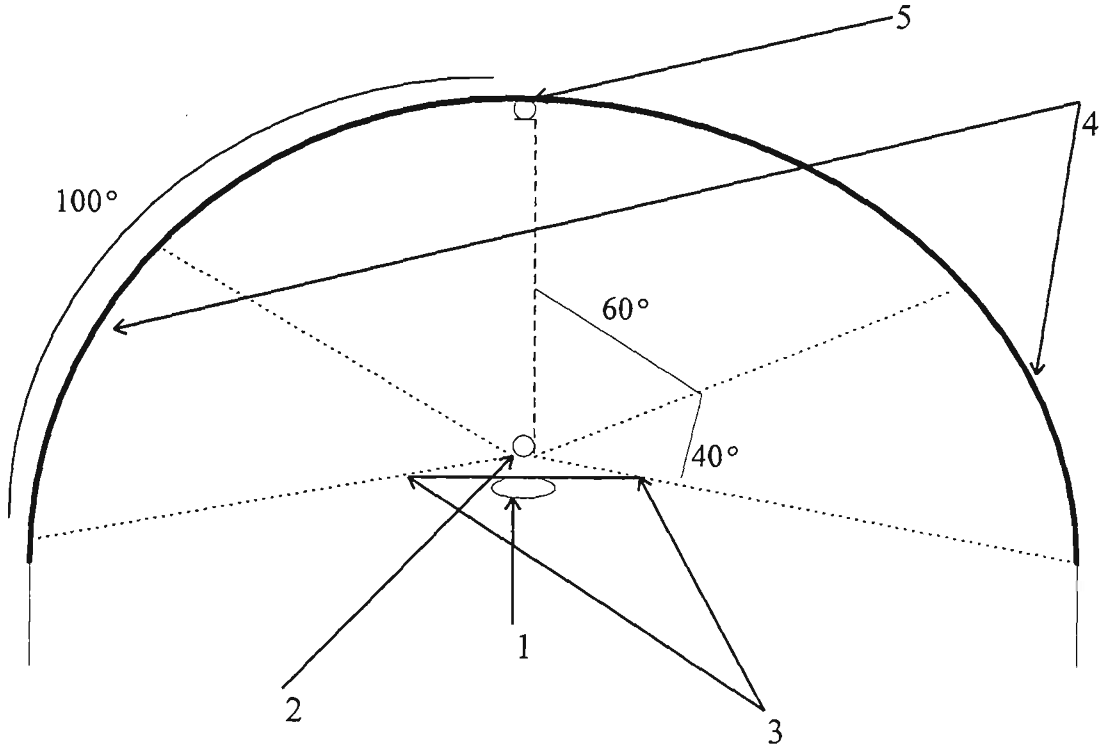
White noise generator. The element of noise was placed in the experiment in order to introduce a level of psychological stress in addition to the physical stress of the physical activity condition. White noise was used because it does not contain attention-attracting features, such as speech. The determination of the level of white noise was based on consideration of two issues. These were, first, avoiding levels of noise which are known to be harmful to people in some way, and, second, using levels of white noise that have been shown to influence performance of tasks like the central-peripheral attention task.

To calibrate the levels of white noise to be used in this research, a B & K Frequency analyser (type 2120) and B & K Artificial Ear (type 4152) were used. This testing was carried out at the Australian Acoustic Laboratories in Melbourne. The white noise was generated by use of a White Noise Generator produced by Lafayette Instrument Company (model # 15011) with standard stereo head phone (model # PH-100). The sound level recorded at the ear was 95 dB. In this study, the 95 dB noise level was chosen because it is below harmful levels, it approximates the noise level at an actual sports event (Suvongvan, 1984), and it is in the range that has demonstrated attentional effects in previous research (Jones, 1983).

Perimeter. For determining central and peripheral visual response time, a modified perimeter was built for use in this research (Figure 4.2). The modified perimeter consisted of a 2 mm thick sheet of aluminium material, 3 m in width and 60 cm in height. It was bent into a semi-circular shape and painted black. It contained the central and peripheral stimuli, which were 5 mm diameter, yellow, light-emitting diodes (LED). These were horizontally placed at 30 cm from the bottom of the modified perimeter. The central target consisted of one light at the central fixation point, that is 0°. The peripheral lights were at angles from 60° to 100° on either side of the central fixation point. In the 40° that contained peripheral lights on either side, there were 64 total lights. The lights were placed 4 cm apart. All central and peripheral lights were connected to an IBM computer, which presented stimuli and recorded responses. The height of the perimeter could be adjusted so that the lights were at eye level for a person seated on the bicycle, because participants were tested on the bicycle in all four conditions. The fixation point was located at eye level in front of the participant, 50 cm from the bridge of the nose. To minimize head movement the participants, while seated on the ergometer, placed their lower jaws upon an adjustable chin rest which was attached to the handlebars of the bicycle ergometer.

Two microswitches were attached to the handle-bars of the bicycle ergometer, one on either side, so that one was next to the resting position of the right hand and the other was next to the resting position of the left hand. Participants were asked to press the switch on the right side with their right index finger when they saw a right side peripheral light go on and to press the switch on the left with their left index finger when they detected that a left side peripheral light had illuminated. As well, a microphone was located on the chin-rest. When the central light came on, starting a timer in the computer, and the participant said "go" into the microphone as quickly ass possible to stop the timer in the computer.

Participants were given sufficient time to practice with these microswitches and the microphone, so that they associated each corresponding stimulus and response, and were not confused during the testing. When the switch was pressed or the microphone activated, the corresponding information, about time from stimulus onset to response, was automatically recorded by the computer. When the participant responded normally, that response was the trigger for the start of an inter-stimulus interval (ISI) of 300-650 milliseconds (ms) for the next trial. An ISI between these times was randomly generated by the computer program. At the end of the ISI the next stimulus was presented. When the participant failed to respond to a stimulus within five seconds of the response to the previous trial, that trial was timed out and recorded as a missed target, and a new stimulus was presented for a new trial. Whether the peripheral light appeared to the left or right and what its angle was (between 60° and 100°) randomised independently by the computer program. The central and peripheral lights were illuminated 120 times in each condition. The central light was illuminated 72 times and the peripheral lights were illuminated 48 times, 24 from each side. The sequence of central and peripheral stimuli was also generated by the computer. The response time was measured in milliseconds (ms) from onset of a light to the registration of the response by the computer, which calculated the response time and stored it.



Key

1. Participant's head on chin rest mounted on bicycle handlebar
2. Microphone mounted on bicycle and located 5 cm from participant's mouth
3. Buttons to be pressed when peripheral light on corresponding side is illuminated
4. Peripheral display of lights - 32 lights 4 cm apart an each side (64 total)
5. Central light

——————— perimeter .... angles of arc

- - - - - - - - - - central light perpendicular to participant

Figure 4.2. Vertical view of perimeter to show distances and angles

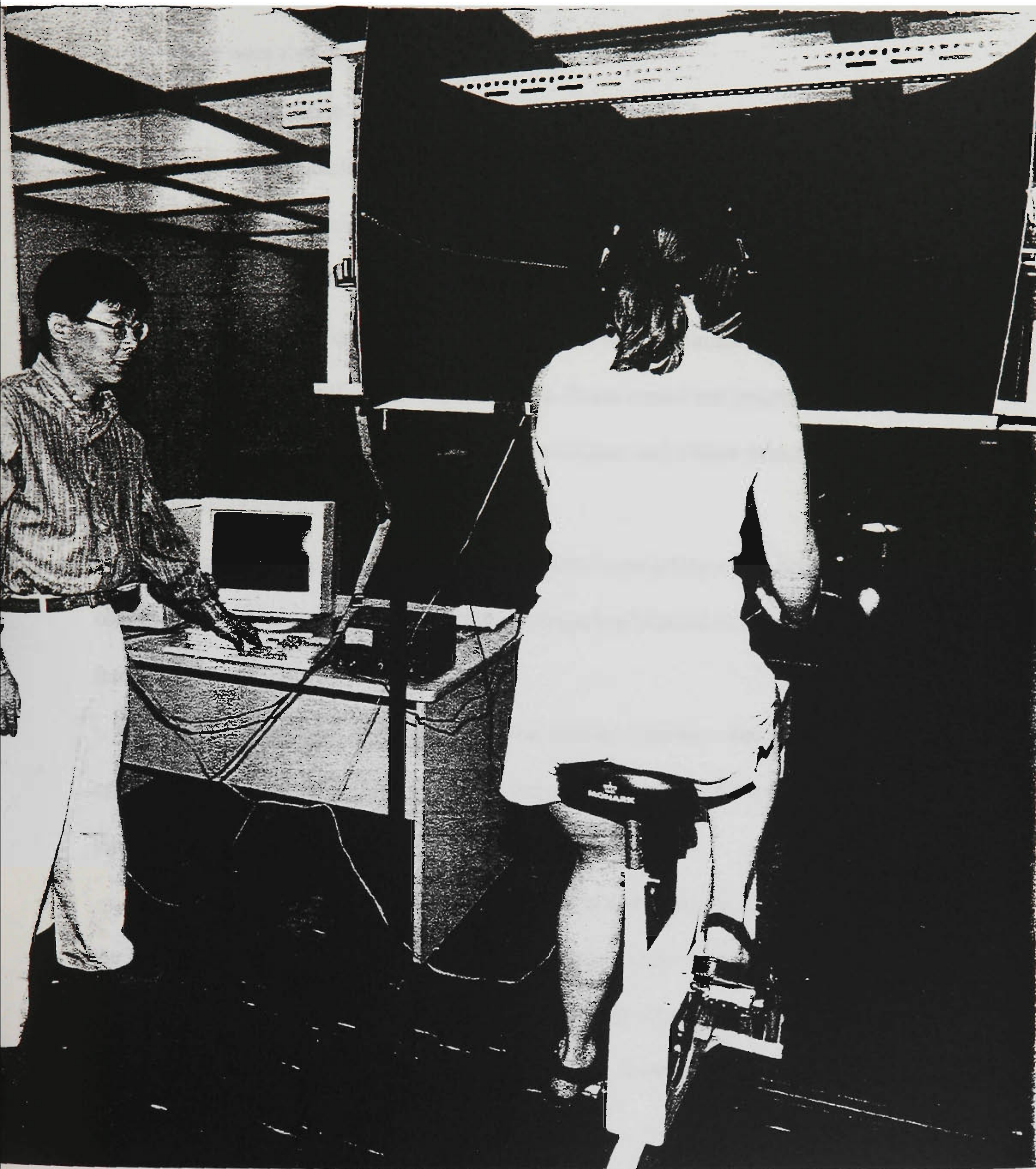


Figure 4.3. Participant in the testing position

Conditions

There were four conditions:

Baseline condition. Participants sat on the bicycle with their feet on the pedals and their hands on the handlebars, wearing headphones, chin in chin-rest, but they did not pedal the bicycle or receive noise stress through the headphones. During the baseline condition, participants responded to 72 stimuli on the central task and 48 stimuli on the peripheral task, that is, the block lasted for 120 stimuli. The numbers of left and right peripheral stimuli were balanced. These central and peripheral lights stayed on continuously, starting any time between 300ms and 600ms from the beginning of the trial until detection.

Noise condition. The noise condition used the same set-up as the baseline condition, but white noise was presented through the headphones, at 95 dB throughout the trial block.

Physical activity condition. The physical activity condition used the same set-up as the baseline condition, but throughout the 120 trial block, participants pedalled the bicycle at 40% of maximum PWC.

Physical activity/noise condition. The physical activity/noise condition used the same method as the baseline condition, but during this condition, which also lasted for 120 stimuli, participants pedalled the bicycle at 40% of maximum workload and they heard 95 dB white noise through the headphones.

Procedure

Before proceeding with testing, participants were informed of the nature of the research, including all tests and procedures, that they were free to withdraw at any time, and that their data would be confidential. They then signed a consent form if they were prepared to volunteer. After signing the consent forms, all participants completed the ALES, ACSI, and SSQ in the laboratory, and then performed the PWC_{170} test on the bicycle ergometer. After testing of physical working capacity, participants had three minutes rest before the practice test. After resting, participants practiced briefly under baseline, noise, physical activity, and physical activity/noise conditions with central and peripheral lights. This was done so that they were familiarised with each condition. This period included an explanation of each piece of equipment and the method for determining the visual measurement (errors, response times) on the peripheral vision testing instrument.

For the practice and for all test conditions, the same procedure was used. While seated on the ergometer, the participant placed their lower jaw upon an adjustable chin rest that was attached to the bicycle ergometer, and this was adjusted to put them in a comfortable position on the bicycle. Toeclips were fitted to the pedals to stop their feet slipping off. In the conditions where the participant had to pedal the bicycle, the participant began to pedal, built up speed to the rate required to achieve a workload of 40% of that person's maximum, and maintained that rate. Then, following a signal that testing was about to start, the central and peripheral targets were randomly lighted under computer control. Throughout the test, regular checks were made of the workload at which the participant was performing. Using hand signals in their central visual field, participants were guided to either increase or decrease their pedal speed to maintain a workload equal to 40% of maximum.

After the practice period, the participant was asked if they were comfortable with the 40% PWC pedalling rate and could maintain it for the duration of the block, and also that the participant fully understood the task. The signal was then made that the first trial block was about to commence. The participant was instructed to start pedalling, if this was either of the conditions involving physical activity, building up to 40% PWC. In the noise and physical activity/noise conditions, the white noise generator was switched on at 95 dB. The computer program that controlled the lights was then started following which the block was run through automatically under computer control. The participants had two minutes break between consecutive conditions. This two minutes rest duration was determined in pilot work. After each break, they proceeded to the next condition in the order to which they were designated. Usually, each block lasted about four minutes. Once they had finished the four conditions, they were debriefed and thanked for their participation. Figure 4.3 shows a participant in the experimental position.

Results

This study examined errors in the detection of central and peripheral visual targets and response times to the onset of these targets, under conditions varying in objective stress. In this section, errors in detection of central and peripheral signals under stress are considered first, then response times for central and peripheral signals under stress are examined, and, finally, the relationship of life stress, social support, and coping skills to response time is analysed.

Errors in Detection of Signals

Central task. The mean number of errors in detection of central targets is shown in Table 4.1, and illustrated in Figure 4.4. The mean detection errors for the central task were low for most conditions, bearing in mind that there were 72 central task trials in each condition. There is a clear step up in mean errors from the baseline and noise only conditions to the physical activity and physical activity/noise conditions. Even in those conditions, participants made less than one error, on average, out of 72 trials.

Table 4.1

Mean Errors in Detection of Central Task (N = 20)

	Condition			
	Baseline	Noise	Physical activity	Physical activity /noise
Central	.25	.10	.60	.70

To test for error in detection of signals in the central task, One-way Analysis of Variance (ANOVA) with repeated measures was performed. The detection errors in the central task was the dependent variable, and the four conditions (baseline, noise, physical activity, physical activity/noise) were levels of the independent variable. The analysis showed that the four levels of stress conditions were significantly related to errors in detection, F (3, 76) = 2.88, $p < .05$. The effect size of η^2 ("eta" squared) was large (.19) for error in detection of signals in the central task. A Newman-Keuls post hoc test indicated that the physical activity and physical activity/noise conditions had significantly ($p < .05$) greater central errors than the baseline and noise alone conditions.

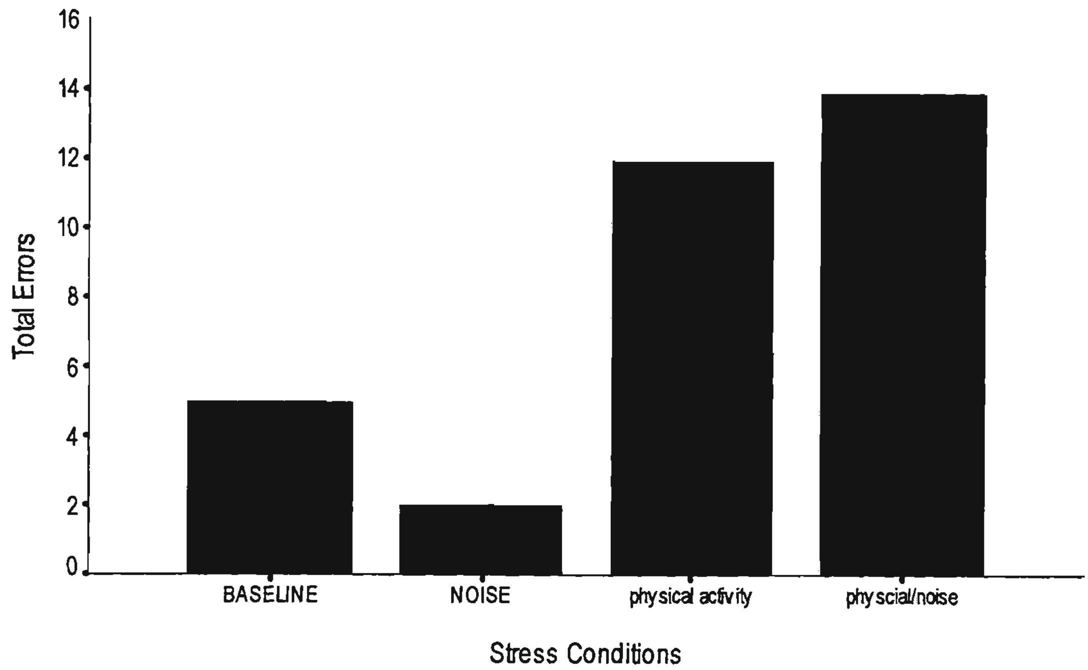


Figure 4.4. Representation of the number of errors in detection for the central task for the four conditions

Peripheral task. The mean number of errors in detection of peripheral targets is shown in Table 4.2, and is illustrated in Figure 4.5. As the peripheral angle increased, there was a gradual increase in the mean number of errors across three of the four conditions. There was a distinct and graduated step up in mean errors from baseline to noise, to physical activity, to physical activity/noise. The one exception was at the 60°-70° angle range, where the baseline error rate was very low and did not change much for the three stress conditions. Table 4.2 also shows the marginal (combined) means for all conditions for all peripheral angles. Both show consistent patterns of increase as the condition became more demanding, either more stressful, or a detection at wider angle. To test for errors in detection of signals in the peripheral task, a two-way ANOVA with repeated measures was performed. The detection errors in the peripheral task was the dependent variable, and the four stress conditions (baseline, noise, physical activity, physical activity/noise), and four angular ranges (60°-70°, 71°-80°, 81°-90°, 91°-100°) were the levels of two independent variables, stress condition and angle respectively.

Table 4.2

Mean Errors in Detection for the Peripheral Task (N = 20)

	Condition				
peripheral angle	Baseline	Noise	Physical activity	Physical activity/noise	Combined
60-70	0	.05	.15	.10	.07
71-80	.10	.30	.50	.60	.37
81-90	.35	.45	.75	.90	.60
91-100	.65	1.05	1.45	2.0	1.2
Combined	.27	.46	.71	.90	

The analysis showed that stress conditions were significantly related to errors in detection, $F(3, 57) = 17.44$, $p < .001$. A Newman-Keuls post hoc test indicated that the main effect of stress conditions was due to a significant ($p < .05$) difference in detection errors between the physical activity and baseline conditions, and between the physical activity/noise and baseline, and noise conditions. Also, angle produced a significant effect, $F(3, 57) = 17.46$, $p < .001$. Newman-Keuls post hoc tests indicated that there were significantly ($p < .05$) more errors in the 91°-100° angle than there were in the three other angles. There were no other significant differences between angles. The stress conditions by angle interaction produced a significant effect, $F(9, 171) = 3.03$, $p < .002$. The effect sizes of η^2 ("eta" squared) were extremely large for stress condition (.48) and angle (.47), and large for the stress conditions by angle interaction (.14).

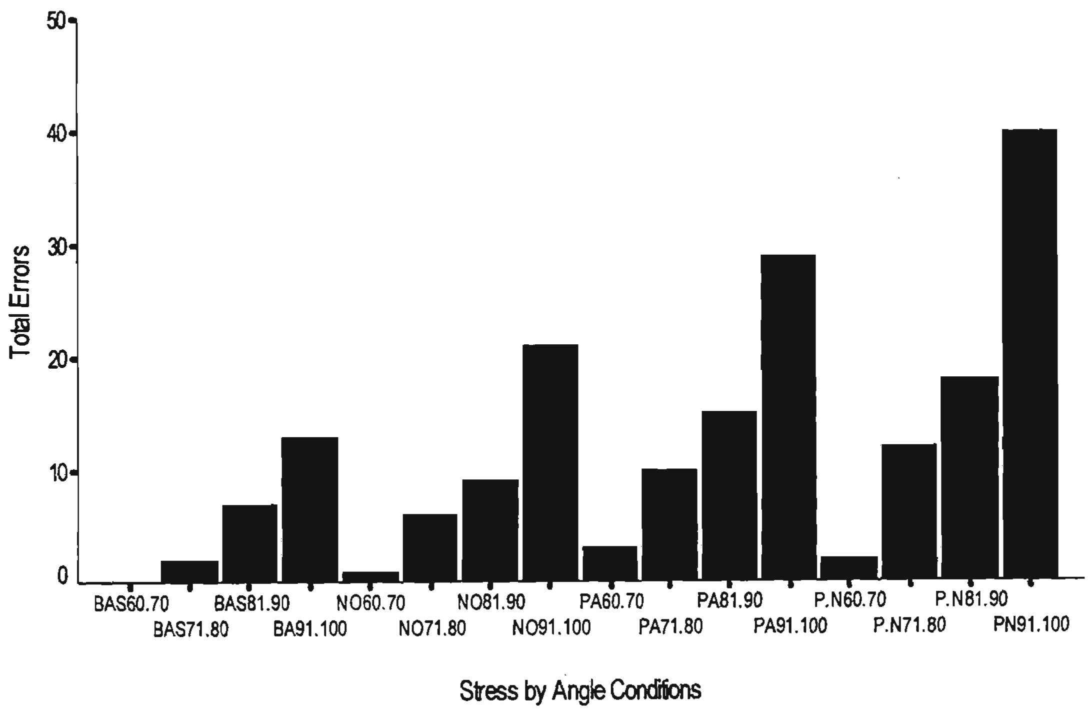


Figure 4.5. The number of errors in peripheral task detection for the four conditions

Newman-Keuls post hoc tests indicated that the stress conditions by angles interaction was due to a significant ($p < .05$) difference in detection errors between the baseline 91°-100° angle range and the 60°-70°, and 71°-80° angle ranges, between the noise 91°-100° angle range, and the 60°-70°, 71°-80°, and 81°-90° angle ranges, between the physical activity 91°-100° angle range, and the 60°-70°, 71°-80°, and 81°-90° angle ranges, and between the physical activity/noise 81°-90° angle range, and the 60°-70° angle range, and the 91°-100°, and 60°-70°, 71°-80°, 81°-90° angle ranges.

Response Time

Central task. The means and standard deviations for response time in the baseline, noise, physical activity, and physical activity/noise conditions on the central task are shown in Table 4.3, and illustrated in Figure 4.6. There was an overall increase across the four conditions in mean central response times from baseline to physical activity/noise. There was also a distinct step up in mean central response times from baseline and noise to physical activity and physical activity/noise.

Table 4.3

Means and Standard Deviations for Central Response Times in Milliseconds (N = 20)

	Baseline		Noise		Physical activity		Physical activity /Noise	
	M	SD	M	SD	M	SD	M	SD
Central task	333	33	348	33	400	27	413	20

To test the effects of stress conditions on central response time, a one-way ANOVA with repeated measures was performed. The central response time was the dependent variable, and the four stress conditions (baseline, noise, physical activity, physical activity /noise) were the levels of the independent variable. The analysis showed that the four levels of stress conditions significantly affected central response time, F (3, 76) = 36.06, $p < .001$. The effect size of η^2 ("eta" squared) was extremely large (.59) for central response time. A Newman-Keuls post hoc test indicated that the physical activity and physical activity/noise conditions had significantly ($p < .05$) longer central response times than the baseline and noise alone conditions.

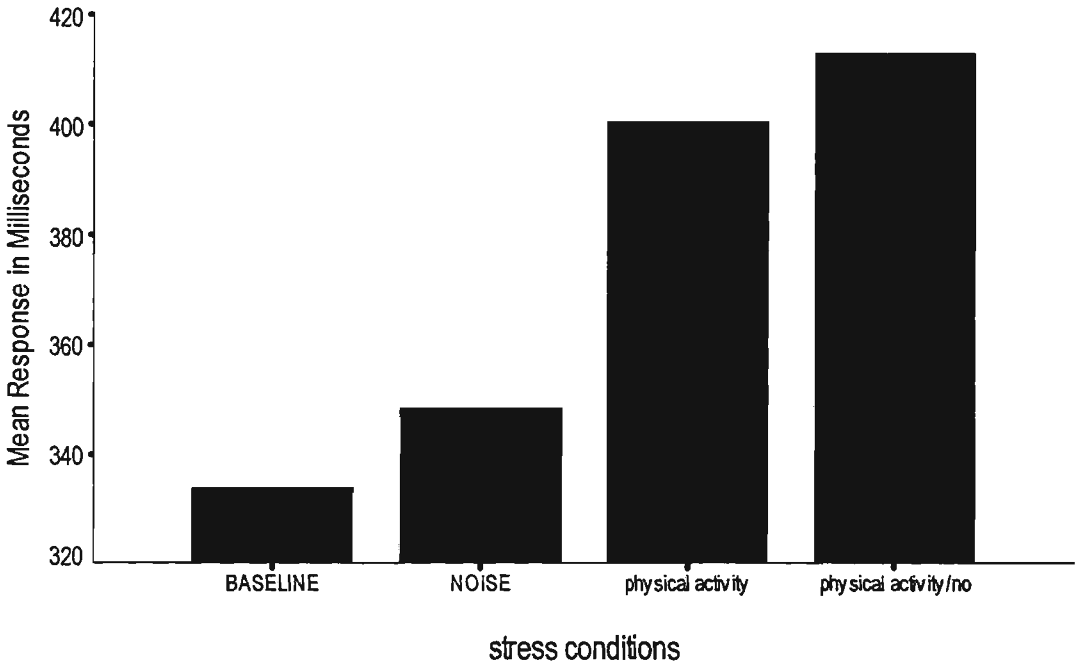


Figure 4.6. Representation of central response time for the four conditions

Peripheral task. The means and standard deviations for response times for the baseline, noise, physical activity, and physical activity/noise conditions for the four peripheral angles for the peripheral task are shown in Table 4.4, and illustrated in Figure 4.7. As the peripheral angle increased, there was an increase in mean response time across the four conditions. This increase was greater for physical activity and physical activity/noise conditions. There was also a step up in mean response time across the conditions for each angle with the exception of the 81°-90° peripheral angle, where there was a step down from baseline to noise. The combined angle means and the combined stress condition means showed these patterns clearly.

To test the effects of stress on response time for peripheral signals, a two-way ANOVA with repeated measures on stress condition and angle was performed. The analysis showed that there was a significant effect on peripheral response time for stress conditions, $F\ (3, 57) = 63.50$, $p < .001$.

Table 4.4

Means and Standard Deviations for Response Times for the Four Conditions and Four Peripheral Angles in Milliseconds (N = 20)

	Baseline		Noise		Physical activity		Physical activity/Noise		Combined	
Peripheral angle	M	SD	M	SD	M	SD	M	SD	M	SD
60-70	348	30	363	57	395	44	416	41	380	43
71-80	378	34	401	56	418	44	451	40	412	43
81-90	494	78	463	70	528	77	567	69	513	73
91-100	581	89	609	117	715	88	785	83	672	94
Combined	450	59	459	75	514	63	554	58		

The post hoc tests indicated that the physical activity and physical activity/noise stress conditions had significantly ($p < .05$) longer peripheral response time than the baseline and noise conditions. Also, angle showed a significant main effect, F (3, 57) = 237.15, $p < .001$. The post hoc test indicated differences between the 91°-100° angle range and the 60°-70°, 71°-80°, and 81°-90° angle ranges. The stress conditions by angles interaction effect was also significant, F (9, 171) = 9.53, $p < .001$. Newman-Keuls post hoc tests indicated that the stress conditions by angles interaction was due to a significant ($p < .05$) difference in peripheral response time between the baseline and the physical activity and physical activity/noise conditions for the 81°-90° and the 91°-100° angle ranges. The effect sizes of η^2 ("eta" squared) were extremely large for stress condition (.77) and angle (.93), and large for the stress conditions by angle interaction (.33) on peripheral response time.

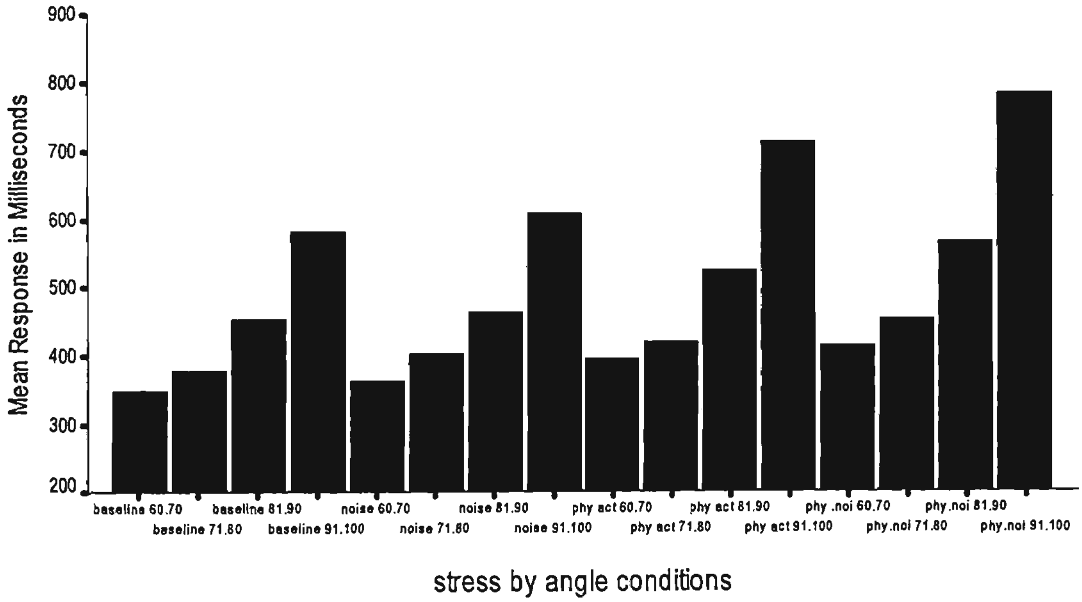


Figure 4.7. Mean response times for the baseline, noise, physical activity, and physical activity/noise conditions and four peripheral angles

Psychosocial Variables

To test the proposition that life stress, social support, and coping skills are related to errors in detection and response time during stressful conditions, a hierarchical multiple regression was performed, using, in order of entry to the regression, Athletic Life Experience Survey Negative (ALESN), Athletic Life Experience Survey Positive (ALESP), Athletic Coping Skills Inventory (ACSI), and Social Support Questionnaire-Satisfaction (SSQ-S) scores as the predictors. Separate multiple regression analyses were conducted for the central and peripheral (60°-100°) errors and response times. Both analyses indicated ALESN, ALESP, ACSI, and SSQ-S to predict changes from the least stressful condition, baseline, to the most stressful condition, noise/physical activity (see Tables 4.5, 4.6).

There were no statistically significant relationships between psychosocial variables, and central and peripheral errors and response times. Changes (incremental R^2) in amount of variance accounted for at each step of the hierarchical regression are found in the note below Tables 4.5, 4.6.

Discussion

The purpose of this study was to investigate the relationship of life stress and visual attentional processing during situations varying in objective stress, within a laboratory setting. This discussion section presents formal conclusions and relates the present results to theory and previous research. It then discusses methodological issues, and the implications of the study for future research and practice.

Formal Conclusions

The results of this study are consistent with past research that showed a relationship between stress and attentional deficits (Williams et al., 1990, 1991; Williams & Andersen, 1997).

Table 4.5

Hierarchical Multiple Regressions of the Psychosocial Predictors of Changes in Central and Peripheral Errors from Baseline to Physical Activity/Noise at the 81°-90° Angle

	Central			Peripheral		
Variable	B	SE B	β	B	SE B	β
Step 1						
ALESN	- .01	.01	- .10	- .01	.01	- .27
Step 2						
ALESN	- .01	.01	- .38	- .01	.01	- .30
ALESP	.03	.02	.44	.01	.01	.04
Step 3						
ALESN	- .01	.01	- .42	- .01	.01	- .34
ALESP	.03	.02	.42	.01	.01	.02
ACSI	.01	.01	.15	.01	.01	.16
Step 4						
ALESN	- .02	.01	- .40	- .01	.01	-.34
ALESP	.02	.02	.31	9.60	.01	.02
ACSI	.01	.01	.25	.01	.01	.16
SSQ	- .03	.03	- .29	- .01	.02	- .02

Note. For Central errors $R^2 = .01$ for Step 1; $\Delta R^2 = .15$ for Step 2; $\Delta R^2 = .06$ for Step 3; $\Delta R^2 = -.14$ for Step 4; Total $R^2 = .05$ ($p > .05$).

For Peripheral errors $R^2 = .07$ for Step 1; $\Delta R^2 = .01$ for Step 2; $\Delta R^2 = .03$ for Step 3; $\Delta R^2 = .01$ for Step 4; Total $R^2 = .12$ ($p > .05$).

Table 4.6

Hierarchical Multiple Regressions of the Psychosocial Predictors of Changes in Central and Peripheral Task Response Times from Baseline to Physical Activity/Noise at the 81°-90° Angle

	Central			Peripheral		
Variable	B	SE B	β	B	SE B	β
Step 1						
ALESN	.29	.56	.12	1.20	.70	.37
Step 2						
ALESN	.52	.74	.21	.81	.91	.25
ALESP	- .67	1.38	- .14	1.13	1.70	.18
Step 3						
ALESN	.54	.78	.22	.56	.92	.17
ALESP	- .66	1.43	- .15	.95	1.67	.15
ACSI	- .07	.77	- .02	1.19	.91	.30
Step 4						
ALESN	.53	.81	.22	.62	.92	.19
ALESP	- .60	1.56	- .33	.35	1.77	.05
ACSI	- .10	.84	- .03	1.50	.95	.38
SSQ	.21	1.91	.03	-2.20	2.16	- .24

Note. For Central response times R^2 = .01 for Step 1; ΔR^2 = .02 for Step 2; ΔR^2 = .01 for Step 3; ΔR^2 = .01 for Step 4; Total R^2 = .05 ($p > .05$).

For Peripheral response times R^2 = .18 for Step 1; ΔR^2 = .03 for Step 2; ΔR^2 = .08 for Step 3; ΔR^2 = .05 for Step 4; Total R^2 = .29 ($p > .05$).

This study, however, did not strong support the existence of a relationship between life-stress, based on the Athletic Life Experience Survey (ALES), the Athletic Coping Skills Inventory (ACSI), and the Social Support Questionnaire (SSQ-6), and central and peripheral signal detection errors or response time for university student athletes.

Errors. The proposition that participants in the stressful conditions, as created by noise, or physical activity, or noise and physical activity, have significantly greater errors in detection of signals from a central target than participants in the baseline condition was supported. This study found that, under the stressful conditions, participants had significantly greater errors in detection of signals from the central target. The proposition that participants in the stressful conditions, as created by noise, or physical activity, or noise and physical activity, have significantly greater error in detection of signals from peripheral targets than participants in the baseline condition was supported. The results showed that, under the stressful conditions, participants had significantly greater error in detection of signals from peripheral targets.

Response time. The proposition that participants in the stressful conditions, as created by noise, or physical activity, or noise and physical activity, have significantly greater response time to signals from the central target than participants in the baseline condition was given substantial support. The proposition that participants in the stressful conditions, as created by noise, or physical activity, or noise and physical activity, have significantly greater response time to peripheral targets than participants in the baseline condition was also supported.

This study found effect sizes for central and peripheral errors in detection, and response times that were all large or extremely large. This indicated that the stressors had a substantial and systematic effect on how participants processed and responded in visual tasks. The large effect sizes for error in detection and response time of central and peripheral tasks indicated that laboratory created situations varying in objective physical and psychological stress strongly affected the task of visual detection in central and peripheral vision and manual or vocal response.

Psychosocial variables. There was no statistically significant relationship between life stress, social support, and coping, and errors and response time to central and peripheral targets under the four stress conditions. Although significance was not achieved for the influence of psychosocial variables on the central and peripheral errors and response time, the multiple regression analyses indicated that negative and positive combined life stress accounted for 15% of the variance in central errors, and negative life stress accounted for 18% of the variance in peripheral response times. In the context of research on psychosocial variables, these are noteworthy influences. The lack of significant difference between groups may be attributed to the small number of participants and subsequent low power of the study.

Relationship to Theory and Research

The greater peripheral narrowing and attentional deficits observed during stressful conditions in the present study are consistent with past research (Hockey, 1970; Kahneman, 1973; Williams et al., 1990, 1991; Williams & Andersen, 1997). According to a study by Williams and Andersen (1997), participants in the stressful conditions had significantly greater error and response time to peripheral targets than participants in the baseline condition. They used a loud verbal and sound effects noise as a stressor along with a Stroop test to examine the relationship between peripheral narrowing and error and response time to peripheral targets. The present study used an additional stress factor, created by physical activity, as well as noise to imitate more closely stress conditions in sport. The results of the present study showed that a combination of stressors, noise and physical activity, lead to greater effects on errors and response times than each did individually. There was also, an increase in errors and response times as peripheral angle increased.

Of particular interest here was the observation that both errors and response time deteriorated, especially in peripheral vision. It has been well-documented (e.g., Magill, 1985) that one way that performers in motor tasks cope with increasing demands is to trade off speed for errors. Thus, where the context or instructions emphasise speed, more errors are made to enhance speed, whereas when errors are critical, performers slow down to minimise them. In the present study, such a strategy was not adopted as both speed and errors got worse under stress. This suggests that some attentional limit might have been affected by the levels of stress imposed. This explanation is not supported by the observation that error rates were not very high, even in the most stressful conditions, although response time increased substantially.

The results of this study are not consistent with past research that reported a relationship between life-event stress and peripheral narrowing (Williams et al., 1990, 1991; Williams & Andersen, 1997). According to a study by Williams et al. (1991), high negative life-event stress lead to significantly greater peripheral narrowing than low negative life-event stress. Williams and Andersen (1997) reported a relationship between life-event stress, social support, psychological coping skills and peripheral narrowing. They also found that there was a direct effect of negative life stress on peripheral narrowing.

A limitation of the present study concerned the questionnaires used to assess life stress, social support, and coping skills. ALES and ACSI are instruments specifically designed for use with high level mature athletes, not Australian physical education students, who are typically not elite athletes nor are they on scholarship, a substantial source of stress for many US college sports performers, as their university career depends on successful performance in their sport to maintain their scholarship. The relatively uniform low scores of the present Australian physical education sample on the ALES are consistent with the profile of these students, who typically lived at home with their parents, playing university sport at a casual level relative to the US college sport system, and who were relatively buffered from a range of stressful life experiences, because their family provided financial and social support. This was supported by the mean age of the sample, which was 22 years. Coping with the competitive pressures of getting into university and playing sport at a competitive, but not elite, level would preclude most people with extremely low coping resources from a university physical education sample. On the other hand, living at home, most of these individuals would not have faced the demands of independent, adult life or high level sport, so they probably had not needed to develop very high level coping resources. This profile was consistent with the moderate scores of most participants on the ACSI. Examination of scores on the SSQ revealed a pattern consistent with life-stress scores, where life-stress was low on average and showed little variability, social support was high, with a mean of 29.9 on a scale ranging from 6 to 36, and also displayed little variability (SD = 4.9). The students who participated in this study mostly lived at home with adequate sources of social support from people who were easily accessible. Thus, while the SSQ is a general measure of social support, this student group was homogeneous, having access to a substantial amount of satisfying social support. The measure of social support recorded and analysed in this study was satisfaction with the quality of the support offered SSQ-S. The SSQ can also be used to assess the sources of social support and the number of sources. This is done using the SSQ-N subscale. To complete this aspect of the SSQ, participants simply list the people who give them support. Andersen and Williams (1997) found that SSQ-N was a good indicator of stress effects on attention, that is, those with greater amounts of support showed less deterioration of attention under stressful conditions. Unfortunately, cursory analysis of the SSQ-N scores for the student group in the present study indicated that they were highly homogeneous, so they were not included in further analyses. Clearly the levels of life-event stress, coping skills, and social support in this relatively small sample do not provide the opportunity for meaningful examination of high/low differences on any of the three scales. In particular, the low variability on each scale makes the use of multiple regression ineffective. Multiple regression is a correlational method which is only effective when scores provide a substantial spread on the scales being examined for their predictive utility. The low variability and positive scores of participants on the life-event stress variables, thus provide a plausible explanation for the difference between the results of the present study and those found with American college student athletes and professional performers. In future studies, greater care is needed in matching measures to samples in research in Australian sport. At the same time, samples of relatively low stress level and homogeneous groups of participants, such as students, are not likely to provide fruitful multiple regression analysis results.

Methodological Issues

This study had an elaborate design, combining a complex task, variables introduced to manipulate stress, and questionnaires used to measure psycho-social stress. In the pilot study, two independent switches were employed, one on either handlebar of the bicycle. Each participant was asked to trigger the right hand switch when responding to an illuminated central light, and the left hand switch when responding to an illuminated peripheral light on either side of the display. It was found that participants were confused by this approach, often triggering the right switch for a right-side peripheral stimulus, and the left switch for a left-side peripheral stimulus. In order to control for this effect, three responses were employed in the main study. A microphone was used to indicate central response, where the participant verbally identified presentation of a central stimulus by the word "go". In addition, the right and left-hand switches were used to indicate the occurrence of a peripheral response corresponding to the illumination of a right or left peripheral light respectively. This produced a higher level of S-R compatibility (Leonard, 1959) and participants showed minimal confusion and incorrect responding once this modification was made. The different modes of response did mean that it was not possible to make direct comparisons between central and peripheral response times under similar conditions. The conditions in the present study do not represent SRT, rather reflecting a three choice situation, with each trial potentially presenting a left peripheral, central, or right peripheral stimulus, so relatively slower hand/finger and verbal responses would be expected, but movement responses would still be expected to be slower than verbal responses (Magill, 1985).

The design was further complicated by the variations in probability of these three signals on any trial. The central signal had a probability of 72/120 (in each condition the signal was used 72 times in a block of 120 signals) or .60, whereas right and left peripheral lights each had a probability of 24/120 (there were 48 peripheral signals in each condition, divided equally between left and right) or .20. Hyman (1952) demonstrated that response time is faster to a more probable stimulus, so response to central stimuli would, again, be expected to be faster than those to peripheral stimuli. It is, thus, difficult to make meaningful comparisons between response times for central and peripheral stimuli. Nonetheless, error rate was lower for central than for peripheral stimuli under all conditions, suggesting that detection of peripheral stimuli was more difficult.

To reduce the effects of errors on the response time, filters were set for upper and lower limits of response time. This discounted responses of less than 200ms and those greater than 1000ms in duration. The computer program discounted these response times before storing the data, so these times were not stored, but recorded as errors. All of these parameters were derived empirically from pilot work. Inter-stimulus intervals were established to ensure the task was demanding, but manageable. Numbers of lights in each condition was set to minimize predictability of onset of peripheral lights, while keeping each block of trials to a length of time for which participants could maintain concentration and hence performance level on the task, when not under stress, minimizing the effects of fatigue.

The numbers of central and peripheral lights were determined from pilot work. The reason for having 72/120 central lights and 48/120 peripheral lights was to reduce predictability by ensuring that the participant could not easily guess where the next illuminated light could come on. In pilot work, I started with the numbers of central and peripheral lights at the same levels. The result appeared to be that the participant knew exactly what to expect. I slowly changed the number of central and peripheral lights until I came to the conclusion that 72 (central) and 48 (peripheral) lights was effective for minimising predictability, especially for the peripheral lights from each side.

In this study, there were four conditions, baseline, noise, physical activity, and physical activity/noise. Each group of participants was subject to the four conditions of the study in one of four predetermined sequences. Each order of conditions was balanced. This approach was employed to minimise any systematic effect that may have occurred due to the order in which the conditions were presented. The white noise was used as one of the stressors, but the noise only condition did not produce as strong effects on errors and response time to central and peripheral target signals as did the other stress conditions, which involved physical activity. It has been found that white noise may result in habituation effects (Wilding & Mohindra, 1980), although the short length of each condition in the present study would not make habituation a convincing explanation. White noise was employed to create a level of psychological stress without introducing specific content that might distract the participants. Any effect of the noise could then be attributed more confidently to stress, rather than to an attentional distraction effect of interesting or novel content, which could occur without stress needing to be present. While the effect of a moderate level of white noise was not large, there was a clear reduction in attention when white noise was involved, especially when it was combined with physical activity, a physical stressor. Having shown that white noise has a stress effect on attention, future research should use irregular crowd noise, such as yelling and speech, not only to increase stress, but also to avoid continuous noise level, because irregular noise has been shown to be more disruptive. Such noise would also simulate sport environments more closely.

The present study used an experimental design, based on the aim of testing part of the Andersen and Williams (1988) model; specifically, to examine the effects of stress and life-stress on central and peripheral visual attention. This design appeared to function effectively for that purpose, so it can be recommended for use in further research on the relationship between stress and visual attention. At the same time, the design of the present study did not permit a distinction to be made between different attentional processes that could underlie the effects observed. The presence of greater decrement at wider peripheral levels might suggest the involvement of peripheral narrowing. Decrements in central vision and in the shallow regions of the periphery suggest that stress might have affected the allocation of attentional resources. It is possible that an attentional resource allocation approach could explain all the findings, as it is can be argued that, under stress, an additional demand on resources lead to more attention being allocated to the central task, either because it was central or because the signals were more probable/frequent. A "strong" peripheral narrowing explanation, where visual attention in the periphery is lost at wide angles under stress, also has difficulty in explaining the graded increase in errors and response time observed as peripheral angle increased, as opposed to a sharp cut-off point.

Implications for Future Research

The present study supported the Andersen and Williams (1988) model link between stress and attention, however, it was not clear what aspects of the stressors were responsible for the decrement in visual attention. Future research should examine different types of stressor to clarify which affect attention and to what extent. This study did not show what mechanism of attention is affected, as just noted. Future research needs to examine attentional narrowing, distractibility, and allocation of resources, because, this study suggested that it was not just a narrowing effect, as the central task was disrupted, and so was the shallow peripheral, but not as much as was the wide peripheral area. The present study did not measure the tension mechanism which could also have been affected, therefore, future research needs to examine muscle tension and to try to distinguish attention and tension effects, as well as to determine the stressors that have their effects on attention or tension or both (e.g., it might be that the psychological stress of noise affects attention and tension, whereas content mainly affects attention). The present study showed that for this sample in this context psycho-social variables did not disrupt attention. This was clearly due to the lack of variability on the psycho-social measures. This indicates that certain groups or types of people might not be prone to psycho-social effects of stress, because their life-event stress is typically low, with high social support and adequate to good coping resources. It would be useful to identify who is likely to have levels of psycho-social variables that could endanger them. In the first study in this thesis, participants, who were club level players, did show relationships between the life stress variables and injury.

Taken together, the results of the studies by Williams and colleagues (Williams et al., 1990, 1991; Williams & Andersen, 1997) do provide support for the effect of stress on visual attention, especially in the periphery. Although a direct link has not been demonstrated, the research that has supported the connection between stress and injury (e.g., Andersen & Williams, 1997; Petrie, 1993b; Summers, Fawkner, & McMurray, 1993) together with the present study and other research that has shown how stress affects attention, suggest that attention could act as a mechanism in the stress-injury relationship. Recently, Kerr and Goss (1996) demonstrated that a stress management program for individuals with high levels of stress reduced the incidence of injury. If it could be demonstrated that such a program, as well as reducing stress, reduced its effects on central and peripheral attention, this would further support the claim that attention is a mechanism underlying the stress-injury relationship. This would appear to be a fruitful line of research using a paradigm like that of the present study.

Implications for Future Practice

The present study has shown that physical activity and noise have effects on attention in a simple laboratory visual attention task, and such an effect is likely to be more potent in complex sports but it is not possible to remove the physical activity, which is part of many sports or even much of the noise, which is inherent in higher level sport where there are large audiences. Thus, practitioners need to develop techniques to moderate the effects of such stressors. While taking part in an experiment can be quite stressful in itself, being a participant in the present study would not have created as much stress as most sport competition. Patterns of life-stress would also be higher in many competitive sport contexts. This suggests the need to monitor these life-stress aspects in real sport contexts. There is certainly evidence to suggest that moderate amounts of stress lead to attentional deficits at levels that could be associated with injuries, so interventions need to be introduced to moderate stress and life-stress in elite sport. Again, interventions can be applied in more specific and sensitive ways. The present study found a clear stress effect of physical activity. This suggests that physical conditioning is important, not merely directly as a protection against injury but also because a less than optimal physical condition, is likely to lead to more stress when the performer is involved in physical activity, leading to a greater attention deficit, and greater risk of injury, especially in club sport.

Concluding Remarks

The major finding from this study was that the participants showed greater attentional deficits under stressful conditions, and that both peripheral errors and response time increased as objective stress was raised by noise and physical activity. The results indicated that the highest level of objectively imposed stress, created by combining the effects of noise and physical activity, produced a greater effect on errors and response times than the moderate levels, created by imposing each stressor individually. There was also an increase in errors and response times as peripheral angle increased. The objective stress was a major variable in participants failing to pick up important cues or narrowing their attention. This loss of visual attention under stressful conditions could result in injury to athletes. These results provide support for the attentional aspect of the Andersen and Williams (1988) model which proposed that an elevated stress response would lead to attentional disruptions (narrowing of the visual field and increased distractibility). The study did not find a relationship between psychosocial variables and central and peripheral response time. Although statistical significance was not found in any of the dependent variables, the multiple regression analyses indicated that the amount variance accounted for was substantial. It was probably due to the small sample size and the use of inappropriate psychosocial measures. More care is needed in matching instruments to participants in future. Although further demonstration of the effects of variations in stress levels on attention, as well as studies using more appropriate psychosocial measures are still needed, there is enough evidence that stress does influence attention, from the present results and those of Williams et al. (1990, 1991), and Williams and Andersen (1997), to warrant exploration of the effects of interventions, which aim to reduce stress and its effects on visual attention. There was a very clear deterioration of attention seen here, under relatively moderate levels of experimentally induced stress. This suggests that the potential for injury due to attentional deficits under the much higher levels of stress and in the more complex task environments of many competitive sports is likely to be great. Thus, the identification of effective interventions, that moderate these attentional effects must be a priority.

Chapter 5: The Effects of Stress and Anxiety Management on Visual Attention

Introduction

When people are in competitive situations, they are forced to deal with many sources of stress, such as anxiety about performance or anticipation of performance, noise, life events, and worry of injury. In attempts to cope with these stressors, a wide variety of techniques, such as relaxation skills (e.g., autogenic training, progressive relaxation, hypnosis), imagery, counselling, thought-stopping, and goal setting may be employed. In recent years, sport psychologists have been studying stressors and stress management techniques to help athletes select methods of dealing with various levels of competitive stress (Brewer, Jeffers, Petitpas, & Van Raalte, 1994; Davis, 1991; Durso-Cupal, 1996; Kerr & Goss, 1996).

In the previous study in this thesis it was demonstrated, consistent with the predictions of the Andersen and Williams (1988) model of stress and athletic injury, that stressful conditions (physical activity and noise) caused a deterioration in central and peripheral visual attention. To understand the mechanisms through which stress management moderates the effect of stress on injury, as well as on performance, the present study examined the effects of a stress management program on central and peripheral visual attention, under stressful conditions.

In the Andersen and Williams (1988) model of stress and athletic injury, it is proposed that physiological and attentional aspects, particularly narrowing of the visual field, that occur during the stress response, may influence injury outcome. Attentional disruptions may be produced by preoccupation with stressful events and their possible negative consequences. Such attentional disruptions reduce peripheral vision and increase distractibility, resulting in injury on some occasions, because the player does not pick up or respond in time to vital or dangerous cues in the periphery (Williams et al., 1990, 1991). Study two in this thesis showed that acute physical and psychological stress did negatively affect both central and peripheral visual attention, which could lead to performance decrements and possible injury.

One purpose of this study was to develop the understanding of one aspect of the Andersen and Williams (1988) model of stress and athletic injury that suggests attentional deficits, particularly, narrowing of the visual field, occur during the stress response. The effects of physical activity and noise stressors on central and peripheral visual perception, were investigated, thus repeating study two with another sample and some modifications to the stressors.

Anxiety is one of the more common reactions to stressors, which can itself affect a person's behaviour. Spielberger (1966) was primarily responsible for elimination of some of the ambiguity in anxiety theory and research by distinguishing between state anxiety and trait anxiety. State anxiety (A-state) refers to "the emotional reaction or response that is evoked in an individual who perceives a particular situation as personally dangerous or frightening for him, irrespective of the presence or absence of a real (objective) danger" (p. 17). Trait anxiety is described as a relatively stable personality characteristic, that predisposes a person to become anxious in a range of situations (Spielberger, 1966). Maynard and Howe (1987) investigated the effects of examination stress on rugby players' scores on the state anxiety scale (A-state) of the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970). The

STAI was administered to these students during a regular class period at the beginning of the summer term (non-stress condition), and subsequently re-administered immediately prior to the final examination for the course (stress condition). The mean state anxiety score in the stress condition was significantly higher than the mean for the non-stress condition.

Anxiety management may help to reduce physiological and psychological stress, promoting optimum attention and performance in athletes during competition. The Andersen and Williams (1988) model predicts that interventions aimed at managing the physiological/attentional aspects of the stress response, will reduce the incidence of athletic injury. Davis (1991) examined the effects of a stress intervention using progressive relaxation and guided imagery. He found a 52% reduction in injuries for swimmers and a 33% reduction in injuries for football players. Kerr and Goss (1996), also, found that a stress management program, based on Meichenbaum's (1985) Stress Inoculation Training, reduced negative athletic stress, total negative stress, and injury. These previous studies, thus, have supported the link between stress management and reduction of the incidence of injury, proposed by the Andersen and Williams (1988) model, but the mechanism by which that reduction occurs is not clarified by this research. It is necessary to test whether such stress management programs reduce the negative impact of stress on visual attention, if influencing the effects of stress on attention is to be shown to be a mechanism by which stress management, leading to reduced stress, lowers the incidence of injury in sport competition.

A number of psychological interventions, such as relaxation skills (e.g., autogenic training, progressive relaxation, hypnosis), meditation, imagery, thought-stopping, and goal setting have been recommended for anxiety management (Benson, 1975; Durso-Cupal, 1996; Goleman, 1988; Harris & Williams, 1993; Jacobson, 1930; Muangnapoe & Morris, 1995; Schultz & Luthe, 1959). Autogenic Training (AT), and modifications of the basic technique, have been found to be effective in the management of stress and anxiety (Davis, Eshelman, & McKay, 1995). Around 1900, a physiologist Oscar Vogt noted that people were able to place themselves in a hypnotic state. The German psychiatrist Johannes Schultz (1953), combined this knowledge with specific exercises to bring about general body warmth and heaviness in the limbs and torso. This autohypnotic relaxation method became known as Autogenic Training and was developed and studied further by Schultz's student Wolfgang Luthe (1969). AT has been considered to be one of the most effective and comprehensive relaxation skills, because AT has been shown to have many beneficial effects including decreased respiratory rate, heart rate, and muscle tension, and reduced anxiety, irritability, and fatigue (Davis et al., 1995; Luthe, 1969).

Thus, as well as repeating the Study 2 examination of the effects of anxiety on visual attention during situations varying in objective stress, this study primarily aimed to investigate the effectiveness of an anxiety management program for reducing the anxiety response to a stressful situation and, hence, the effect of the program on visual attention in such circumstances. Specifically, this experiment examined predictions of the Andersen and Williams model (1988) of stress and injury, by using an AT intervention, to reduce state anxiety in stressful conditions and investigating whether this enhanced central and peripheral visual attention under stress.

Research Propositions

The research propositions are stated in the experimental form and are one tail in direction. All testing is at the $p < .05$ significance level. Propositions are presented separately for the examination of the effects of stress on central and peripheral visual attention and the investigation of the effects of an anxiety management technique on central and peripheral visual attention under that stress.

The Effects of Stress on Visual Attention (Pre-intervention)

Central task. 1. In the physical activity and physical activity/noise conditions, participants will have significantly greater detection errors for central targets than in the baseline condition.

2. In the physical activity and physical activity/noise conditions, participants will have significantly greater response times to central targets than in the baseline condition.

Peripheral task. 1. In the physical activity and physical activity/noise conditions, participants will have significantly greater detection errors to peripheral targets than in the baseline condition.

2. In the physical activity and physical activity/noise conditions, participants will have significantly greater response time to peripheral targets than in the baseline condition.

Peripheral angle. 1. Participants will have significantly greater peripheral detection errors and response times as the peripheral angle increases.

2. In the physical activity and noise conditions, participants will have significantly greater increases in peripheral error and response time as the peripheral angle increases compared to the baseline condition.

The Effects of Anxiety Management Program on Visual Attention (Post-intervention)

1. The anxiety management group will have significantly greater reduction in state anxiety from pre-test to post-test than the control group.

2. The anxiety management group will have significantly greater reduction in error and response time for the central task from pre-test to post-test than the control group.

3. The anxiety management group will have significantly greater reduction in error and response time for the peripheral task from pre-test to post-test than the control group.

4. The anxiety management group will have significantly greater reduction in error and response time than the control group from pre-test to post-test, as the peripheral angle increases.

Method

Participants

The participants were 24 physical education students (12 males, 12 females) ranging in age from 19 to 25 from the Victoria University of Technology. All participants took part regularly in at least one competitive sport activity for a minimum of five hours per week. All participants were volunteers and they completed a standard consent form (see Appendix C).

Research Design

Before proceeding with testing, all participants completed the A-state scale of the State-Trait Anxiety Inventory (STAI), and then performed the Physical Working Capacity (PWC_{170}) test. The visual attention test was completed under three stress conditions: baseline, physical activity, and physical activity/noise. These were presented in balanced order, as shown in Figure 5.1, each order involving eight participants. Participants sat on a bicycle ergometer wearing headphones, which only functioned in the physical activity/noise condition. The 83-95 decibel (dB), noise was based on typical crowd noise associated with competition, such as speech and cheering at sports events. Participants only pedalled the bicycle in the physical activity and physical activity/noise conditions, maintaining the work rate of 40% of PWC, determined by the PWC test. In each condition, participants responded to 72 stimuli on the central task and 48 stimuli on the peripheral task, where number of stimuli from left and right was balanced. The number of stimuli from each peripheral angle was also balanced and the 48 stimuli were presented in random order with respect to side and angle. After each condition, the participants had two minutes break.

After this pre-testing of attention under three different conditions of stress induction, the participants were divided randomly within each sex into a treatment group (12) and a control group (12). The treatment group received the stress reduction program for an eight-week period. The program took the form of Autogenic Training. The control group had no contact during the treatment period. After eight weeks, each group was re-tested on the visual attention task. Each individual was tested with a different order of conditions, and, again, the order of conditions was balanced across the sample. Figure 5.1 summarises the whole design.

Pre - test

Order	Condition			
1 (8 participants)	complete questionnaire (STAI) PWC170 test	baseline	physical activity	physical activity /noise
2 (8 participants)		physical activity /noise	baseline	physical activity
3 (8 participants)		physical activity	physical activity /noise	baseline

Treatment Period

Treatment group (12 participants)	Control group (12 participants)
with Autogenic Relaxation for 8 weeks	no contact for 8 weeks

Post - test

Order	Condition			
1 (8 participants)	complete questionnaire (STAI)	baseline	physical activity	physical activity /noise
2 (8 participants)		physical activity /noise	baseline	physical activity
3 (8 participants)		physical activity	physical activity /noise	baseline

Figure 5.1. Research design including three balanced orders

Measures

A-State Scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970). The State Anxiety Scale (A-State) of the State-Trait Anxiety Inventory (STAI) was used to measure the level of state anxiety of participants at the time of pre-test and post-test. This A-State scale consists of 20 self-statements concerning the emotional state of the person "at this moment in time" (e.g., I feel calm; I feel nervous). Each item is scored on a 4-point Likert scale, ranging from 1 (not at all) to 4 (very much so). Spielberger et al. (1970) reported a test-retest reliability of, $r = .32$, and internal consistency coefficients ranged from, $\alpha = .83$ to $\alpha = .92$. The test-retest value may be considered low, but is expected because the A-State scale is a state measure, which fluctuates from moment to moment. The STAI has been one of the most widely used tests in psychology over the past 25 years, both in research and in applied work. In the present laboratory context, it was not appropriate to use sport specific measures, such as the Sport Competition Anxiety Test (SCAT; Martens, 1977) because anxiety was not being assessed in the sport context.

The Physical Working Capacity (PWC) $_{170}$ Test (Astrand & Rodahl, 1977). The same physical workload test (PWC_{170}) was used in exactly the same way as reported in the Method section of Study two in this thesis (see Chapter 4).

Apparatus

Monark bicycle ergometer. The same Monark bicycle ergometer was used in exactly the same way as described in the Method section of Study two in this thesis (see Chapter 4). It created a level of physical stress.

Noise. The element of noise was placed in the experiment in order to introduce a level of psychological stress in addition to the physical stress of the physical activity condition. In this study, irregular crowd noise such as yelling and speech at sports events was chosen to increase stress. The determination of the crowd noise is based on consideration of two issues. These are, first, avoiding types of continuous noise, such as white noise, which may result in habituation effects, and, second, using crowd noise that has already been shown to influence performance on tasks like the central-peripheral attention task (Wilding & Mobindra, 1980).

The classic research by Broadbent (1954), Hockey (1970), and Jones (1983), examining the effects of noise stress on the performance of attentional tasks, typically found that 95 or 100 dB noise had negative effects on performance, whereas results for 90 dB noise were much more variable. These studies were conducted on individuals who were seated quietly. Griffiths (1970) reported that an auditory stimulus could be considered weak if it were under a sound pressure of 70 dB, while a moderate stimulus would generally fall between 70 and 95 dB, and a high intensity stimulus would be one which is 95-120 dB.

To calibrate the levels of crowd noise to be used in this research, a B & K Frequency analyser (type 2120) and B & K Artificial Ear (type 4152) were used. This testing was carried out at the Australian Acoustic Laboratories in Melbourne. The crowd noise was generated by use of a recording of a soccer crowd produced by Digimode Ltd (SP 11032, track 37), played on a Sony Walkman (Model WM-F 404) with standard ear phone. The minimum sound level recorded at the ear was 83 dB and the maximum 95 dB. In this study, the 83 to 95 dB noise level was chosen because it is below harmful levels, it approximates the noise level at an actual sports event (Suvongvan, 1984), and it is in the range which has demonstrated attentional effects in previous research (Jones, 1983).

Perimeter. The same perimeter was used in exactly the same way as described in the Method section of Study two in this thesis (see Chapter 4).

Conditions

In the previous study in this thesis, visual attention was examined under four stress conditions, namely baseline, noise, physical activity, and physical activity/noise. In this study, three stress conditions were employed. These were baseline, physical activity, and physical activity/noise. This was done, because the noise only condition differed little from the baseline condition in examination of the data in Study two. It was unnecessary to include it in an already extensive experimental procedure.

Baseline condition. Participants sat on the bicycle with their feet on the pedals and their hands on the handlebars and wearing headphones, but they did not pedal the bicycle or receive any noise stress through the headphones. During the control condition, participants responded to 72 stimuli on the central task and 48 stimuli on the peripheral task, that is, the block lasted for 120 stimuli. The numbers of left and right peripheral stimuli were balanced.

Physical activity condition. The physical activity condition used the same set-up as the control condition, but throughout the 120 stimulus block, participants pedalled the bicycle at 40% of maximum PWC.

Physical activity/noise condition. The physical activity/noise condition used the same method as the control condition, but during this condition which also lasted for 120 stimuli, participants pedalled the bicycle at 40% of maximum workload and they received 83-95 dB crowd noise through the headphones.

Anxiety Management Program

The treatment technique for stress reduction was Autogenic Training (AT) following a modified version of the procedure developed by Schultz and Luthe (1959). AT is a relaxation technique that uses the bodily sensations of warmth and heaviness to first relax areas of the body, such as the limbs and torso, and then this relaxed state is extended by the use of imagery (Luthe, 1969). AT is useful in reducing headaches, anxiety, muscle tension, heart rate, and fatigue (Greenberg, 1983). According to Schultz and Luthe, there are several essential factors to successful AT. These factors are: 1) high motivation and co-operation on the part of the participant, 2) a reasonable degree of participant self-direction and control, 3) maintenance of a particular body posture comfortably, 4) reduction of external stimuli to a minimum, 5) minimum of sensory reception, 6) focus on internal physiological processes, and 7) maintenance of a strong sense of concentration

As Schultz and Luthe suggested, there are three basic postures which are recommended for doing AT. The easiest and best position is a lying-down position on a carpeted floor or bed, feet slightly apart, toes leaning away from body, and arms resting comfortably at the sides. Sometimes pillows or cushions may be used under the head and knees for support. If circumstances do not permit lying down, then a seated position in a chair is recommended.

Stage 1: Heaviness

* My arms and hands feel heavy.

* My legs and feet feel heavy.

* My arms and legs feel heavy.

Stage 2: Warmth

* My arms and hands feel warm.

* My legs and feet feel warm.

* My arms and legs feel warm.

Stage 3: Heart

* My heart is calm and relaxed.

* My heart beat is slow and relaxed.

Stage 4: Respiration

* My breathing is calm and relaxed.

* It breathes me.

Stage 5: Solar Plexus

* My stomach area is warm.

Stage 6: Forehead

* My forehead is cool.

* My entire body is calm and relaxed.

Figure 5.2. Six initial stages of Autogenic Training

The best chair to use is a straight-backed one that provides support for the head and aligns it with the torso. The second seated position uses a stool chair in which the person sits without support for the back. The position here is to sit on a stool, with posture slightly stooped over, with arms resting on the thighs and hands draped between the knees. Whichever position is chosen, the body should be tension free and relaxed.

AT consists of six initial stages which provide a range of stress management effects. Each involves a number of brief auto-suggestions about bodily sensations. These are presented in Figure 5.2. This training was undertaken by the participants for eight weeks. The participants practised regularly; this meant at least once per day for 25 minutes, going right through all six stages during each practice session. Their practice was recorded on practice record sheets.

Procedure

Before proceeding with testing, participants were informed of the nature of the research, including all tests and procedures, that they were free to withdraw at any time, and that their data would be confidential. They then signed a consent form if they were prepared to volunteer. After signing the consent forms, all participants completed the STAI in the laboratory, and then performed the Physical Working Capacity (PWC_{170}) test on the bicycle ergometer. After testing of physical working capacity, participants had three minutes rest before the practice test. After resting, participants practised for five minutes under baseline, physical activity, and physical activity/noise conditions with central and peripheral lights. This was done so that they became equally familiarised with each condition. This period included an explanation of each piece of equipment and the method for determining the visual measurement (errors, response times) on the peripheral vision testing instrument. This period of instructions also presented an adequate rest from the physical exertion of the PWC test.

For the practice and for all test conditions, the same procedure was used, as follows. While seated on the ergometer, the participant placed their lower jaws upon an adjustable chin rest, which was attached to the bicycle ergometer, and this was adjusted to put them in a comfortable position on the bicycle. The fixation point, that is, the centre of the central target, was then adjusted so that it was located in front of the participant 50 cm from the bridge of the nose and at eye height as the participant sat on the bicycle ergometer with hands on the handlebars and index fingers over the two response buttons. Toeclips were fitted to the pedals to stop their feet slipping off. In the conditions where the participant had to pedal the bicycle, the participant began to pedal, built up speed to the rate required to achieve a workload of 40% of that person's maximum (PWC_{170}), and maintained that rate until stabilised. Then, following a signal that testing was about to start, the central and peripheral targets were randomly lighted under computer control. Participants pressed the switch on the right side as quickly as possible when they saw a right side peripheral light go on and pressed the switch on the left as quickly as they could when they detected a left side peripheral light. When the central light illuminated, the participant said "go" into the microphone as quickly as they could. It was emphasised that it was important for the participant to react as quickly as possible to central and peripheral signals, because response times were being recorded for both. Each participant received 120 stimuli during each condition. The central lights illuminated 72 times and the peripheral lights illuminated 48 times randomly to right or left, and the numbers of left and right peripheral lights were balanced within each condition. The peripheral lights included the four angle ranges (60°-70°; 71°-80°; 81°-90°; 91°-100°) with stimuli balanced across them. Throughout the test, regular checks were made of the workload at which the participant was performing. Using hand signals in their central visual field, I guided participants to either increase or decrease their pedal speed to maintain a workload equal to 40% of maximum. This technique appeared to work effectively, causing little distraction once practice on the ergometer had established the appropriate pedal speed. It was typically needed only very occasionally. Participants practised for five minutes prior to the actual test.

The experiment consisted of three conditions, baseline, physical activity, and physical activity/noise, which were presented in balanced order, as shown in Figure 5.1. Each order involved eight participants. The participants sat on the bicycle wearing headphones in all three conditions. After the practice period, I checked that the participant was comfortable with the 40% PWC pedalling rate and could maintain it for the duration of the block, and also that the participant fully understood the task. I then indicated that the first trial block was about to commence. The participant was instructed to start pedalling if this was either of the conditions involving physical activity, building up to 40% PWC. In the physical activity/noise condition, I switched on the tape-recorded noise at 83-95 dB. In all conditions, the computer program, which controlled the lights, was then started, following which the block was run through automatically under computer control. The participants had two minutes break between consecutive conditions. This two minutes rest was determined in pilot work to ensure that the was no build-up of physical or psychological fatigue. After each break, they proceeded to the next condition in the order to which they were designated.

After this pre-testing in all three conditions, the participants were assigned at random to a treatment group or a control group. The treatment group received the stress reduction program for a period of eight weeks. The program took the form of AT. This technique was described in full in the previous section. The participants in the treatment group were given an AT guideline paper, an AT tape, and practice record sheets (see Appendix K). Once a week, I met the participants to discuss their progress and any difficulties. They received an introduction to AT in a quiet room, using an audio tape. During the playing of the AT tape, I observed the reaction of the participants and later recorded comments about the participants' feelings. Then each participant practised daily in a place of their choosing and at a time that was convenient to them. I periodically checked practice record sheets. The control group was not contacted in any way during the eight week period. Neither group knew about the existence of the other group.

After eight weeks, each group was re-tested using the same methods as in the pre-test to examine the effects of the anxiety management program. This post-test involved the same PWC_{170} value, the same three minutes rest, five minutes practice period, and rest period prior to testing under the three stress conditions. Each participant was assigned to a different order of conditions from that used at pre-test and received the same two minutes breaks between consecutive conditions. Once participants had finished the three conditions, they were debriefed, any problems resolved, and they were thanked for their participation.

Results

This study had two aims, firstly, to do another test of the effects of stress on central and peripheral visual attention under similar conditions to Study two, except using crowd noise and no noise only condition, and secondly, to examine the effects of an anxiety management program on those stress effects. In this study, four peripheral angle ranges were employed, but the peripheral targets from only three angular ranges, 71°-80°, 81°-90°, and 91°-100° from the central light were analysed. The 60°-70° angle range was dropped from the analysis, because it was considered to be only on the borderline of being peripheral and the effects were clear across the other three conditions. The Results section first examines the effects of the stressors at pre-test and then investigates the influence of the AT anxiety management program for the treatment group, compared to the control group, from pre- to post-intervention.

Stress Effects on Central and Peripheral Visual Attention at Pre-intervention

Errors in Detection of Signals

Central task. The mean of errors in detection of central targets is shown in Table 5.1, and illustrated in Figure 5.3. There is a clear step up in mean errors from the baseline condition to the physical activity and physical activity/noise conditions, participants an average, missing one out of 72 targets for the stressful conditions and around a quarter of a target, an average, in the baseline condition.

Table 5.1

Mean Errors in Detection of Central Task (N = 24)

	Condition		
	Baseline	Physical activity	Physical activity /noise
Central task	.29	1.04	1.20

To test for error in detection of signals in the central task, One-way Analysis of Variance (ANOVA) with repeated measures was performed. The detection errors in the central task was the dependent variable, and the three conditions (baseline, physical activity, physical activity/noise) were levels of the independent variable.

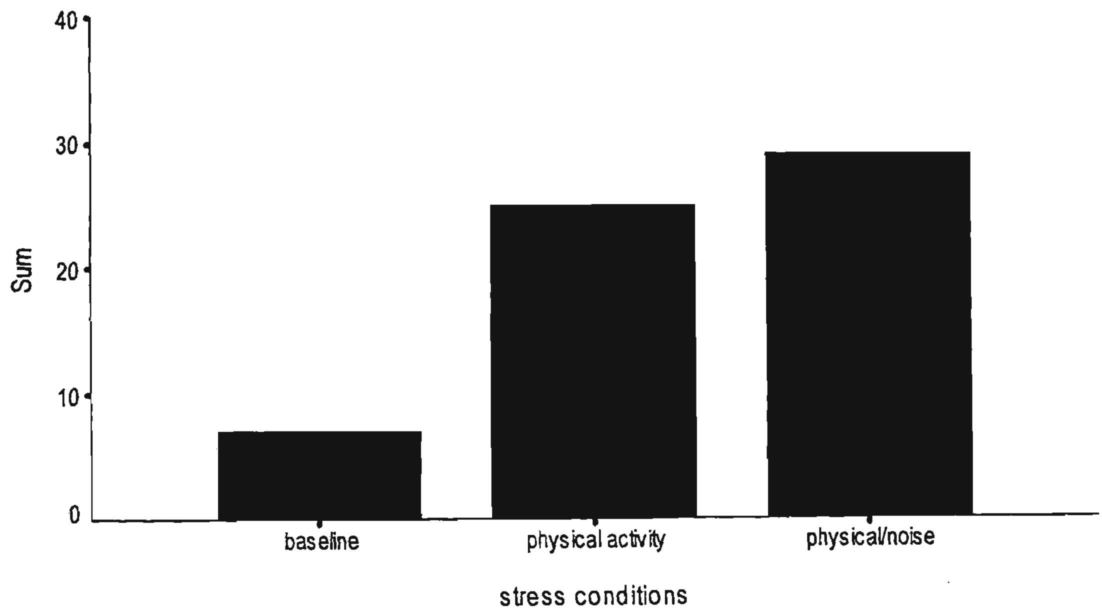


Figure 5.3. Representation of the number of errors in detection for the central task for the three conditions

The analysis showed that the three levels of stress conditions were significantly related to errors in detection, $F(2, 69) = 7.32$, $p < .001$. The effect size of η^2 ("eta" squared) was quite large (.32) for error in detection of signals in the central task. Newman-Keuls post hoc tests indicated that the main effect of stress conditions reflected a significantly ($p < .05$) greater difference in detection errors for physical activity and physical activity/noise than for the baseline condition.

Peripheral task. The mean of errors in detection of peripheral targets is shown in Table 5.2, and is illustrated in Figure 5.4. As the peripheral angle increased, there was a gradual increase in the mean number of errors across the three conditions. As for the central task, there was a greater difference in mean errors from baseline to physical activity and physical activity/noise conditions, than between physical activity and physical activity/noise conditions. The combined angles and stress conditions show these patterns very clearly.

Table 5.2

Mean of Errors in Detection for the Peripheral Task (N = 24)

	Condition			
peripheral angle	Baseline	Physical activity	Physical activity/noise	Combined
71-80	.37	1.12	1.16	.88
81-90	.54	1.25	1.62	1.13
91-100	.87	2.41	2.91	2.06
Combined	.59	1.59	1.89	

To test for error in detection of signals in the peripheral task, a two-way ANOVA, with repeated measures was performed. The detection errors in the peripheral task was the dependent variable, and the three stress conditions (baseline, physical activity, physical activity/noise), and three angular ranges (71°-80°, 81°-90°, 91°-100°) were levels of two independent variables, stress and angle respectively.

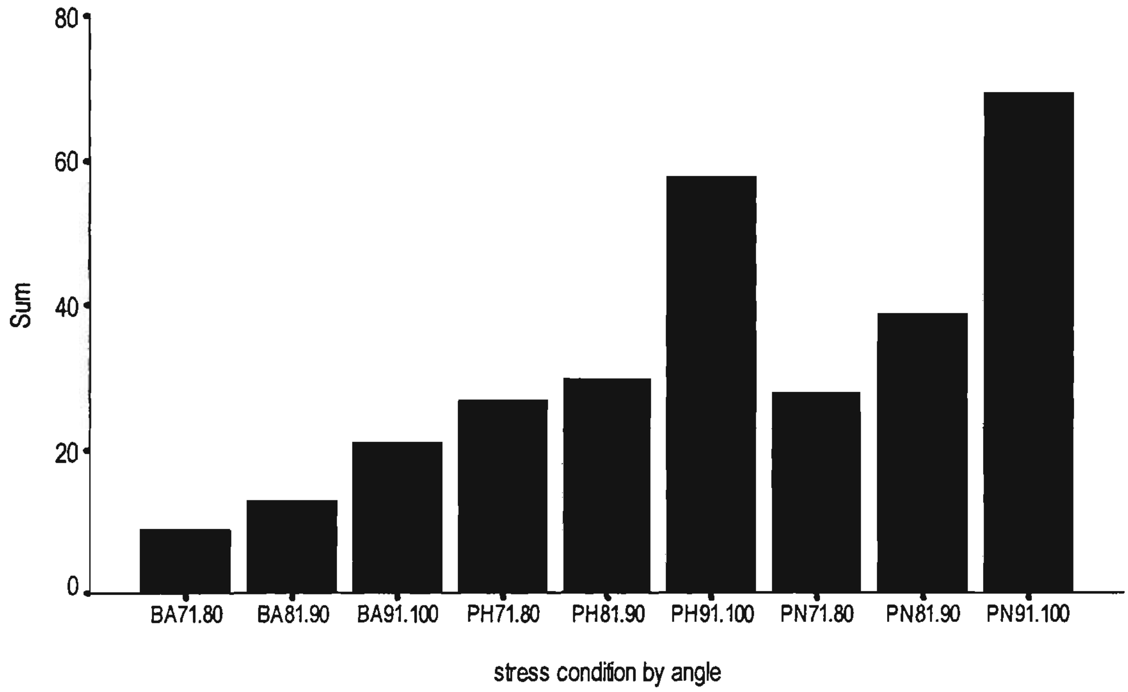


Figure 5.4. Number of errors in peripheral task detection for the three conditions

The analysis showed that the main effect of stress conditions was significantly related to errors in detection, F (2, 46) = 148.40, $p < .001$. Newman-Keuls post hoc test indicated that for the main effect of stress conditions, there was a significantly ($p < .05$) greater difference in detection errors for physical activity and physical activity/noise over the baseline condition. Also, the main effect of angle produced a significant effect F (2, 46) = 25.06, $p < .001$. The post hoc test indicated that the main effect of angles were a significant difference ($p < .05$) for 91°-100°, compared with the 71°-80°, 81°-90° angle ranges. The stress conditions by angle interaction produced a significant effect, F (4, 92) = 5.82, $p < .001$. The post hoc test indicated that there was a significant difference ($p < .05$) in detection errors for physical activity and physical activity/noise at the 91°-100° angle range, compared with these conditions at the 71°-80° and 81°-90° angle ranges. The effect sizes of η^2 ("eta" squared) were extremely large for stress conditions (.86) and angle (.52), and large for stress conditions by angle interaction (.20).

Response Time

Central task. The means and standard deviations for response time in the baseline, physical activity, and physical activity/noise conditions on the central task are shown in Table 5.3, and illustrated in Figure 5.5. There was an overall increase across the three conditions in central response times from baseline to physical activity/noise.

Table 5.3

Means and Standard Deviations for Central Response Times in Milliseconds ($N = 24$)

	Baseline		Physical activity		Physical activity /Noise	
	M	SD	M	SD	M	SD
Central task	335	31	378	34	399	28

To test for the effects of stress conditions on central response time, a one-way ANOVA with repeated measures was performed. The central response time was the dependent variable, and the three stress conditions (baseline, physical activity, physical activity/noise) were levels of the independent variable.The analysis showed that three levels of stress conditions were significantly related to central response time, F (2. 69) = 25.51, $p < .001$. The effect size of η^2 ("eta" squared) was extremely large (.59) for stress conditions on central response time. A Newman-Keuls post hoc test indicated that the main effect of stress conditions indicated a significant difference ($p < .05$) in central response time for physical activity compared to the baseline condition, and for physical activity/noise compared to the physical activity and baseline conditions.

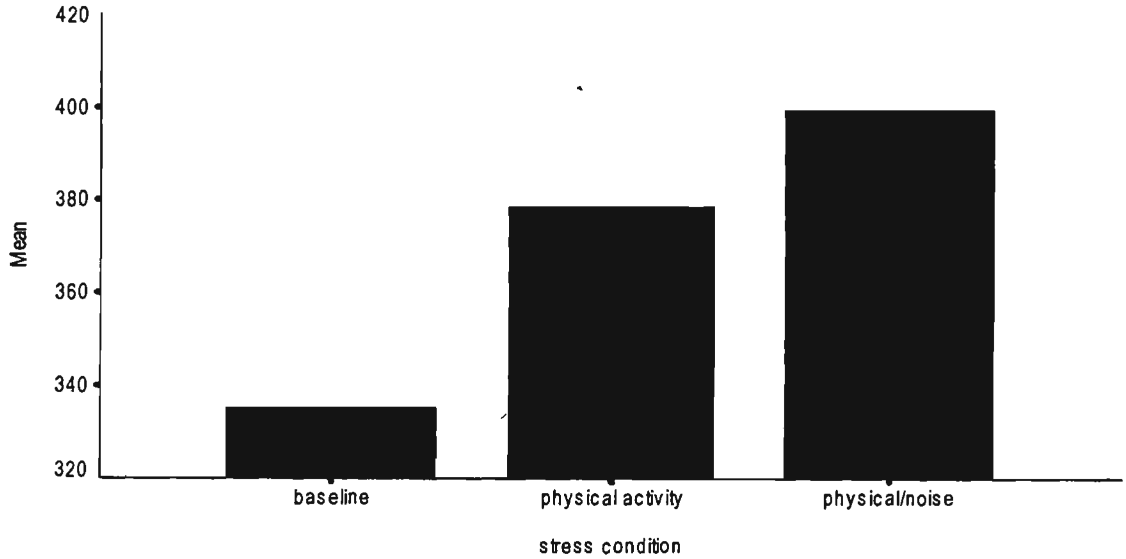


Figure 5.5. Representation of central response time for the three conditions

Peripheral task. The means and standard deviations for response times for the baseline, physical activity, and physical activity/noise conditions for the three peripheral angles are shown in Table 5.4, and illustrated in Figure 5.6. As the peripheral angle increased, there was an increase in mean response time across the three conditions. There was also a step up in mean response time across the conditions for each angle.

To test the effects of stress on response time for peripheral signals, a two-way ANOVA with repeated measures was performed. The peripheral response time was the dependent variable, and the two independent variables were stress conditions and angles. The analysis showed that there was a significant main effect of stress condition on peripheral response time, $F(2, 46) = 148.94$, $p < .001$. The post hoc test indicated that the main effect of stress conditions reflected significantly ($p < .05$) longer peripheral response times for physical activity and physical activity/noise than for the baseline condition.

Table 5.4

Means and Standard Deviations for Response Times for the Three Conditions and Three Peripheral Angles in Milliseconds (N = 24)

	Baseline		Physical activity		Physical activity/Noise		Combined	
Peripheral angle	M	SD	M	SD	M	SD	M	SD
71-80	364	61	392	26	405	22	387	36
81-90	443	57	556	69	596	71	531	65
91-100	523	85	684	118	724	106	643	103
Combined	443	67	544	71	575	66		

Also, angle showed a significant main effect, $F(2, 46) = 85.90$, $p < .001$. The post hoc test indicated that the response times for angles were significantly ($p < .05$) different for 81°-90° than for 71°-80°, and for 91°-100°, than for 71°-80° and 81°-90°. The stress conditions by angles interaction effect was also significant, $F(4, 92) = 133.26$, $p < .001$. The post hoc test indicated that the stress conditions by angles interaction reflected a significantly ($p < .05$) longer peripheral response time for the three stress conditions at the 81°-90° angle range, than at the 71°-80° angle range, and for the 91°-100° angle range, than at the 71°-80° and 81°-90° angle ranges. The effect sizes of η^2 ("eta" squared) were extremely large for stress conditions (.86), angle (.78), and stress conditions by angles interaction (.85) on peripheral response time.

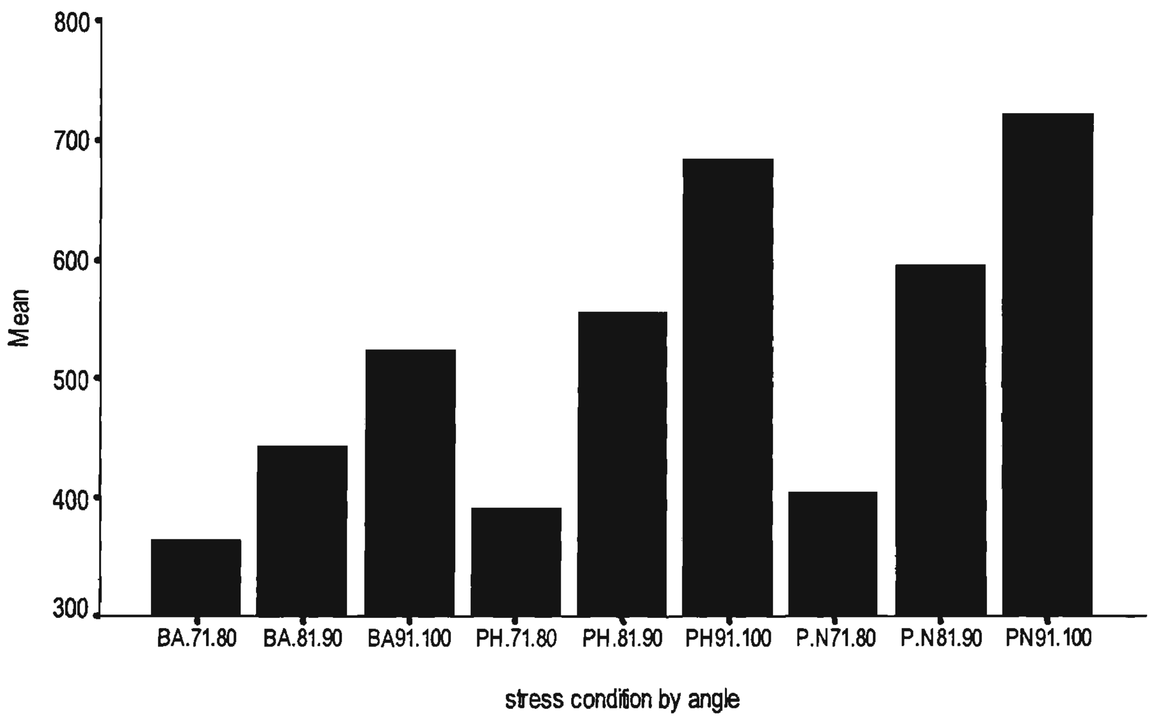


Figure 5.6. Mean response times for the baseline, physical activity, and physical activity/noise conditions and three peripheral angles

Effects of the Anxiety Management Program on Central and Peripheral Visual Attention

Data Analysis

When a pre-test and post-test design has been used to examine the effects of a treatment or control, a very common approach in psychological research has been to perform a mixed design Analysis of Variance (ANOVA), with repeated measures on occasions and the treatments as a between groups factor. Some time ago, Huck and McLean (1975) pointed out that this design tends to underestimate the F value for the treatment effect. The reason this happens is that the ANOVA model assumes that the treatments affect all occasions, so the pre-test scores are tested as part of the treatment effect, but treatment groups are usually matched at pre-test or participants are randomly assigned to treatments, with the assumption that this will result in no difference between groups on the dependent variable(s). Thus, by including the pre-test data in the analysis as part of the treatment effect, the ANOVA reduces the actual effect, which only occurs at post-test. Based on the same reasoning, the interaction effect in a 2×2 mixed design ANOVA, where the first occasion is the pre-test, actually represents the main effect of the treatment.

Huck and McLean suggested two alternative methods of analysis to avoid making this error of underestimation of the F-value. These were the use of gain scores and covariance analysis. Covariance is applied to this situation by analysing post-test scores by Analysis of Covariance (ANCOVA), using the pre-test score as the covariate. In gain score analysis, the scores of participants at pre-test are subtracted from their post-test scores and ANOVA is then used to examine post-test differences. Huck and McLean argued that, because the same assumptions apply to it and gain score analysis, but more information is produced by an ANCOVA analysis, ANCOVA is marginally the preferred method.

An issue that has become much more common in psychological research since Huck and McLean's paper was published is the analysis of state variables. ANCOVA assumes that a covariate exerts a relatively stable effect on the dependent variable, for example, the way a person's trait anxiety might affect their state anxiety on many occasions. By definition, state anxiety does not exert a stable effect, instead varying from time to time. The following analyses of main effects of treatment and interactions between treatments, stress levels, and peripheral angles employ gain scores, because pre-test scores on the state anxiety measures do not reflect stable variables to use as a covariate. For state anxiety, pre-test score is subtracted from post-test score and the resulting gain or change score is compared for the treatment and control groups using the One-way ANOVA. For errors and response times, in each case, pre-test score for one stress level and peripheral angle is subtracted from the corresponding stress level and peripheral angle post-test score and the resulting scores are analysed using mixed design ANOVA. In the case of central task data, two-way ANOVA is employed to examine repeated measures on stress levels and the independent groups factor of treatment. For the peripheral task, three-way ANOVA is used to examine repeated measures on stress levels and on peripheral angles, as well as the independent groups factor of treatment.

Results for Pre- to Post-intervention Gain Scores

State Anxiety

The means and standard deviations of STAI A-State gain scores for the treatment group and control group are shown in Table 5.5. This table depicts a substantial negative gain for the treatment group, with a small positive gain for the control group.

To test the hypothesis that the anxiety management treatment group would have significantly greater reduction in state anxiety from pre-test to post-test than the control group, A-State scale gain scores were compared for the treatment and control groups, using a one-way ANOVA. A-State gain scores indicated that the treatment group had significantly, $F\ (1, 22) = 5.29$, $p < .03$, greater reduction in state anxiety from pre-test to post-test than the control group.

Table 5.5

Means and Standard Deviations of STAI Gain Scores (N =24)

Treatment group		Control group	
M	SD	M	SD
- 3.58	5.03	.50	3.52

Errors in Detection of Signals

Central task. The means and standard deviations of gain score of errors in detection of central lights in the three conditions for the treatment and control group are shown in Table 5.6. While very small gain score means are shown for the baseline and physical activity conditions, there was a negative gain for the treatment group and a positive gain for the control group in the physical activity/noise condition.

Table 5.6

Means and Standard Deviations of Gain Scores of Errors for Central Task (N = 24)

	Baseline		Physical activity		Physical activity/noise	
	M	SD	M	SD	M	SD
Treatment group	- .16	.38	.16	.93	- .41	.90
Control group	- .08	.51	.08	.66	.25	.75

To test for differences between treatments, occasions, or their interaction for gain scores of error in detection of signals in the central task, a two-way ANOVA was performed, with repeated measures on the stress factor, with three levels (baseline, physical activity, physical activity/noise) and the independent groups factor, treatment, with two levels (treatment, control). The analysis showed that treatment group was not significantly related to errors in detection, F (1, 22) = 1.67, $p > .2$, stress condition was also not significantly related to errors in detection, F (2, 44) = .84, $p > .4$. Also, the treatment group by stress condition interaction was found not to be significant, F (2, 44) = 1.81, $p > .1$. The effect sizes of η^2 ("eta" squared) were medium for treatment group (.07), treatment group by stress conditions (.07), and small-medium for stress conditions (.03).

Peripheral task. The means and standard deviations of gain score of errors in detection of peripheral signals in the three conditions for the treatment and control groups are shown in Table 5.7. This applies to all peripheral task analyses. Gain scores are typically very small, but the 81-90° and 91-100° angles show relatively larger negative gain scores for the treatment group and positive gain scores for the control group in the physical activity/noise condition.

Table 5.7

Means and Standard Deviations of Gain Scores of Errors for Peripheral Task (N = 24)

		Baseline		Physical activity		Physical activity /noise	
	angle	M	SD	M	SD	M	SD
Treatment group	71-80	- .08	.66	- .14	1.02	.16	1.02
	81-90	.00	.85	.12	1.40	- .33	1.30
	91-100	- .16	1.46	- .16	1.33	- .66	1.15
Control group	71-80	- .08	.99	- .08	1.16	- .33	.88
	81-90	- .16	1.11	.41	1.24	.58	1.44
	91-100	- .08	.79	.91	1.31	.33	1.82

To test for significant differences between gain scores of errors in detection of signals in the peripheral task, a three-way ANOVA with repeated measures on two factors, stress conditions and angles, each with three levels and the independent groups factor, treatment, with two levels, was performed. The analysis showed that treatment group was not significantly related to errors in detection, $F\ (1, 22) = 2.58$, $p > .1$, and stress condition was not significantly related to errors in detection, $F\ (2, 44) = 1.98$, $p > .1$. Angle was also not significantly related to errors in detection, $F\ (2, 44) = .63$, $p > .5$. The effect sizes of η^2 ("eta" squared) were small for angle (.02), medium-large for treatment group (.10), and large for stress conditions (.19). The group by stress condition interaction was not found to be significant, $F\ (2, 44) = 2.04$, $p > .1$, and the group by angle interaction was not found to be significant, $F\ (2, 44) = 1.22$, $p > .3$. The stress condition by angle interaction was also not found to be significant, $F\ (4, 88) = .60$, $p > .6$. Also, the group by stress condition by angle interaction did not produce a significant effect, $F\ (4, 88) = .81$, $p > .5$. The effect sizes of η^2 ("eta" squared) were small for stress conditions by angle (.02), small-medium for stress condition by angle by group (.03), and small-large for group by angle (.05) and medium for group by stress condition (.08).

Response Time

Central task. The means and standard deviations of gain scores for response time to central signals in the three conditions for the treatment and control groups are shown in Table 5.8, and illustrated in Figure 5.7. While there were small negative gains for the control group in all conditions, and for the treatment group in the baseline condition, notably larger negative gains in response times were observed for the treatment group in the physical activity and physical activity/noise conditions.

Table 5.8

Means and Standard Deviations of Gain Scores for Central Response Times (N = 24)

	Baseline		Physical activity		Physical activity/noise	
	M	SD	M	SD	M	SD
Treatment group	- 2.58	7.85	-17.08	19.03	-23.33	16.50
Control group	-1.00	9.35	-7.33	9.53	-5.50	11.12

To test the effects of stress on central response time, a two-way ANOVA was performed, with repeated measures on three stress levels (baseline, physical activity, physical activity/noise) and an independent groups factor, treatment (Autogenic Training, control). The analysis showed that treatment group had a significant effect on central response time, F (1, 22) = 6.57, $p < .01$. Stress condition was also significantly related to central response time, F (2, 44) = 9.08, $p < .001$. Also, the group by stress condition interaction was found to be significant, F (2, 44) = 3.30, $p < .04$. The effect sizes of η^2 ("eta" squared) were large for all of treatment (.23), stress condition (.29), and treatment group by stress condition (.13). The post hoc analysis indicated that, while there was no significant difference ($p = .05$) between the response time gain scores for the treatment and control groups for the baseline condition, the treatment group showed a significantly ($p < .05$) larger negative gain score than the control group for the physical activity condition and for the physical activity/noise condition.

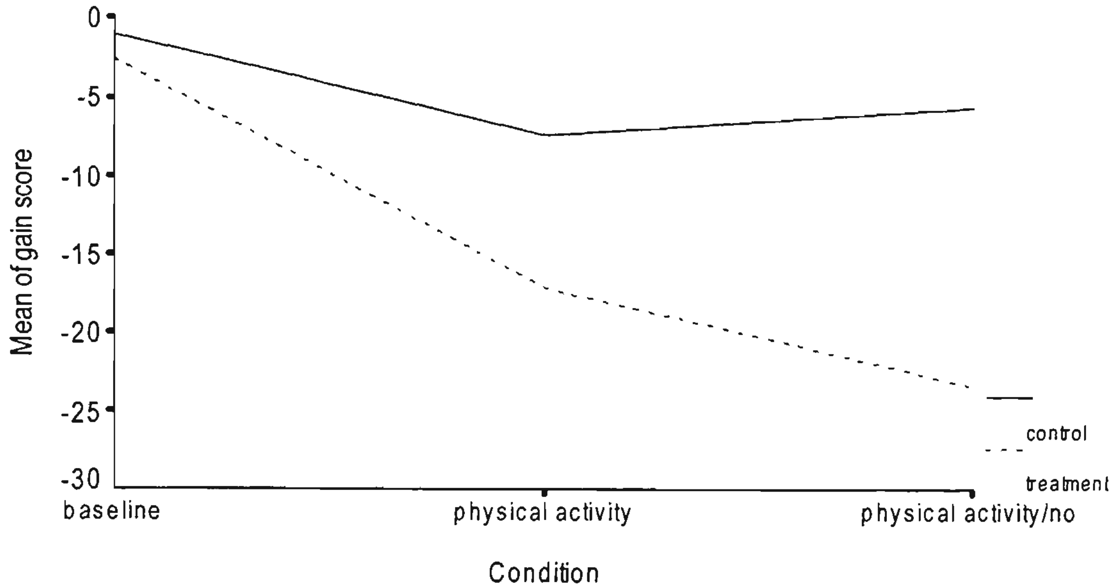


Figure 5.7. Gain scores for central response time for the three conditions in the treatment and control groups

Peripheral task. The means and standard deviations of gain scores from pre-test to post-test for peripheral response times in the three conditions for the treatment group and control group are shown in Table 5.9, and the main effects of angles and treatment groups and their interaction are illustrated in Figure 5.8. Figure 5.8 shows that as the peripheral angle increased, there was a larger negative gain in response times across the three conditions for the treatment group compared to the control group, where the negative gains were close to zero.

To test the effects of stress on response time to peripheral signals, a three-way ANOVA was performed with repeated measures on conditions (baseline, physical activity, physical activity/noise) and on peripheral angle (71°-80°, 81°-90°, and

91°-100°) and the independent groups factor of treatments (Autogenic Training, control).

Table 5.9.

Means and Standard Deviations of Gain Scores for Peripheral Response Times (N = 24)

		Baseline		Physical activity		Physical activity /noise	
	angle	M	SD	M	SD	M	SD
Treatment group	71-80	- .25	10.7	-2.66	18.9	-9.50	14.3
	81-90	-35.75	27.6	-36.33	22.7	-23.41	26.8
	91-100	-34.66	41.7	-50.75	65.9	-70.75	68.8
Control group	71-80	-1.83	11.4	3.41	21.7	-3.50	21.6
	81-90	-24.00	33.8	-17.16	43.8	3.25	24.2
	91-100	-15.50	45.1	-8.41	61.2	-7.75	44.0

The analysis showed that the treatment group had a significant effect on peripheral response time, F (1, 22) = 6.87, $p < .01$. Angle was also significantly related to peripheral response time, F (2, 44) = 8.61, $p < .001$. The post hoc test indicated that there were significantly ($p < .05$) larger negative gain scores for the 81°-90° angle and for the 91°-100° angle range, than for the 71°-80° range. The main effect for stress condition was not significant, F (2, 44) = .01, $p > .9$. The effect sizes of η^2 ("eta" squared) observed large for treatment group (.23) and angle

(.28), and small for stress conditions (.01). The treatment group by angle interaction was significant, F (2, 44) = 3.59, $p <$ .03. The treatment group by stress condition interaction was not found to be significant, F (2, 44) = 2.46, $p >$ .09. The stress condition by angle interaction was also not found to be significant, F (4, 88) = 2.19, $p >$ .07. Also, the group by stress condition by angle interaction did not produce a significant effect, F (4, 88) = .57, $p >$ .6. The only significant effect for an interaction was for the treatment groups by angles. The post hoc analysis revealed that the only significant ($p <$ .05) difference in peripheral response time between the treatment groups occurred for the 91°-100° angle range as shown in Figure 5.8. The effect sizes of η^2 ("eta" squared) were small for group by stress conditions by angle (.02), and medium-large for group by stress condition (.10) and stress condition by angle (.09), and large for group by angle (.14).

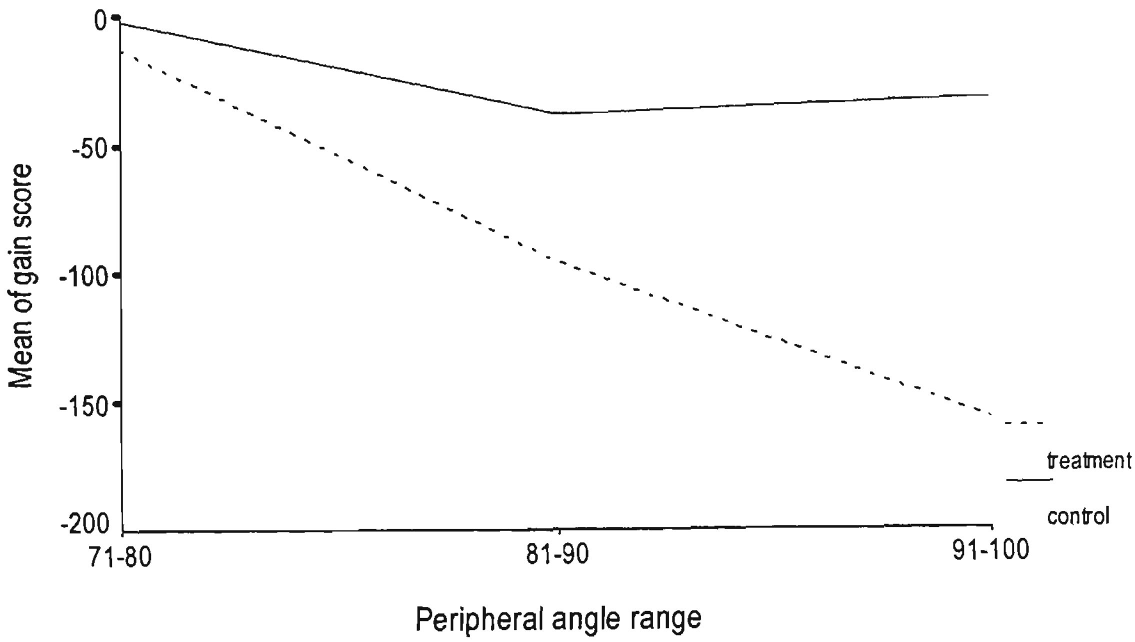


Figure 5.8. Gain scores for peripheral response time for the three angles in the treatment and control groups

Discussion

The purpose of this study was to examine the effectiveness of an AT anxiety management program for reducing the state anxiety response, and the effect of the program on central and peripheral visual attention during stressful situations in a laboratory setting. The results of this study are consistent with past research that has shown a relationship between stress, anxiety, and attentional deficits (Williams et al., 1990, 1991; Williams & Andersen, 1997), and research that has demonstrated the effects of stress management programs on sports injuries (Davis, 1991; Kerr & Goss, 1996).

Summary of Conclusions

Effects of Stress on Visual Attention

This study found that pre-intervention results supported the previous study in this thesis. The results showed that, under the stressful conditions, as created by physical activity, or noise and physical activity, participants had significantly greater errors in detection of signals from the central and peripheral task, than participants in the baseline condition. Errors also increased significantly as peripheral angle increased. In addition, the stress condition by angle interaction, involving three levels of stress conditions by three angles, led to greater errors as both stress and angle increased, than did each variable individually. Significant differences were shown in post hoc tests for the physical activity and the physical activity/noise conditions, each at 91°-100° angle range, compared with the 71°-80°, 81°-90° angle ranges.

The pre-intervention showed that, under the stressful conditions, participants had significantly greater response time in detection of signals from the central and peripheral task, than participants in the baseline condition. It was also shown that response time increased significantly for larger peripheral angles. The results showed that the physical activity and physical activity/noise conditions had significantly greater central response times than the baseline. Also, participants had significantly greater response time to peripheral signals under the two most stressful conditions, physical activity, and noise/physical activity. As the peripheral angle increased from 71°-80°, through and 81°-90°, to 91°-100°, response time was longer. Significant differences were shown in Newman-Keuls post hoc tests for these differences, thus supporting those hypotheses. The stress condition by angle interaction revealed significantly longer response times for three stress conditions at the 81°-90° angle range, than at the 71°-80° angle range, and for the 91°-100° angle range, than for the 71°-80°, 81°-90° angle ranges. This indicated that as the peripheral angle increased, there was an increase in response time across the three conditions, that was greater than the stress and angle effects independently.

Effects of Anxiety Management on Stress and Visual Attention

In this study, a significant reduction in state anxiety from pre- to post-intervention was observed for the anxiety management treatment group compared to the control group. Analysis of Variance on gain scores from pre- to post-intervention indicated significant reduction in central and peripheral response times in the physical activity and physical activity/noise conditions for the anxiety management treatment group compared to the control group. Again, these were greater at wider peripheral angles. This study found that there was no significant effect of the AT anxiety management program on errors in central and peripheral visual attention.

The proposition that the AT anxiety management treatment group would have a significantly greater reduction in state anxiety from pre- to post-intervention compared to the control group was supported. This study found that the anxiety management program was effective in reducing the state anxiety levels of the participants. The proposition that the AT treatment group would have a significantly greater reduction from pre- to post-intervention for central response time in the two stress conditions than the control group was supported. Based on gain analyses, the results showed that the AT treatment group overall had a significantly larger decrease in response times across the three conditions than the control group. The parallel proposition for the peripheral response time was also supported. Also, as the peripheral angle increased from 71°-80° to 81°-90°, and to 91°-100°, there was a significantly larger decrease in response times across the three conditions for the AT treatment group compared to the control group. The results indicated that the treatment group and angle significantly affected response time, and the treatment group by angle interaction was also significant. Post hoc tests showed that the only significant difference in peripheral response time between the treatment groups and angles occurred for the 91°-100° angle. The results indicate that, for the treatment group, the AT program had a significant effect on response time for detection for signals, depending on the peripheral angle, but there was no effect of the three stress conditions, based on having done the anxiety management program.

Although there was a significant reduction in state anxiety from pre- to post-intervention, a limitation of this research is that state anxiety was only measured before the stress conditions. Future research should measure state anxiety both before and after the stress conditions from pre- to post-intervention. This will provide a more detailed description of the effects of the experimental protocol on an individual's anxiety prior to and following stress management training.

According to the Andersen and Williams (1988) model of stress and athletic injury, physiological and attentional changes, particularly increased general muscle tension, narrowing of the visual field, and increased distractibility, that occur during the stress response in athletic situations, may influence injury outcome. The relationship between stress, anxiety, and attentional deficits during stressful conditions was examined by Williams et al. (1990, 1991), and by Williams and Andersen (1997). They found that athletes with high life stress, when placed in a stressful situation, experienced greater narrowing of peripheral vision and state anxiety than athletes with low life stress. The results of the pre-intervention component of the present study are consistent with this past research that reported the greater peripheral narrowing, attentional deficits, and anxiety during stressful conditions (Williams & Andersen, 1997; Williams et al., 1990, 1991). Williams and Andersen (1997) reported that participants in the stressful condition had significantly slower reaction times and increases in failure to detect cues than participants in the baseline condition. One limitation of these studies and the present study is that they examined only attentional aspects, such as narrowing of the visual field, and increased distractibility. They did not measure physiological aspects during the stress response. Future research should not only examine the attentional changes, but also physiological changes, such as general muscle tension, using electromyography (EMG) measures taken during the stressful conditions.

In their model, Andersen and Williams (1988) proposed that stress management interventions (e.g., autogenic training, meditation, relaxation skills, imagery) for the physiological/attentional aspects of the stress response, may reduce the incidence of athletic injury. The present study is consistent with past research that reported the effects of a stress management program (Davis, 1991; Kerr & Goss, 1996). There has been little research, that has examined the effect of stress management programs on anxiety and attentional deficits, which is one of the primary mechanisms proposed by Andersen and Williams to be responsible for the stress-injury relationship. The present study examined the effectiveness of an AT anxiety management program for reducing the state anxiety response, and the effect of the program on central and peripheral visual attention during stressful situations. There was no support for any of the propositions concerning the effects of the AT program on errors in central or peripheral vision. This indicates that the AT program did not affect errors in detection for central and peripheral tasks. These results may have been due to the very small number of total errors at pre-test under most stressful conditions, making it difficult to detect any trends from pre-test to post-test. In fact, the results might reflect the difficulty of reducing the number of errors which was very low in most conditions at pre-test. The failure of this study to achieve a statistically significant result for total errors may, therefore, be due to a "floor effect" caused by the low number of total errors recorded in the pre-test.

During the eight-week treatment period the participants in the anxiety management treatment group practised daily in their own time, and they met me once a week to review their ability to perform AT and to check their practice record sheets.

The practice record sheets were completed after each daily AT practice. The participants who practised AT recorded approximately 80% positive comments in the comment columns. Typical examples of these positive comments include: feel good, feel better, feel comfortable. The other 20% was left blank. If I had met the participants more often than once a week, for guided AT practice, results from the AT treatment might have been stronger still. In the description of AT in the Method section, several factors that are considered to be essential to the success of AT were identified from the writing of Schultz and Luthe (1959). The following observations were made about the 12 participants who practised AT over the eight week period. The motivation of the participants who practised AT was high and the co-operation was very good. The participants attended all activities or made contact with me when unable to attend. Among the 12 participants, eight participants expressed a desire to continue AT practise after the study. As noted earlier, all participants completed a very high percentage of the practise logs. When the participants met me once a week to practise AT, they used the most conducive posture for AT which is the lying-down position on the floor. The room in which they practised AT was very quiet; there were few external stimuli.

In the previous study in this thesis, white noise was used as one of the stress conditions, but in this study crowd noise, such as yelling and speech at sports events, was chosen to increase stress, because white noise may result in habituation effects (Wilding & Mohindra, 1980). During measuring sound level, it was found that there is about 4 to 6 dB difference in sound level between the electrical sound generated and the actual sound heard. Therefore, it is very important to measure noise level at the ear.

The major finding from pre-intervention, in this study, supported the previous study in this thesis. The results showed that, under the stressful conditions, as created by physical and physical plus psychological (noise) stress, participants had significantly greater errors and response time in detection of signals from the central and peripheral task, which increased for larger peripheral angles, than participants in the baseline condition. Also, the results for pre-intervention and post-intervention gain scores demonstrated that the treatment group, that received the AT anxiety management program, had significantly greater reductions in state anxiety and response times than the control group. The effect occurred for central and peripheral signals, but was most noticeable for wide peripheral angles. These results provide support for the Andersen and Williams (1988) model of stress and athletic injury, which proposes that attentional deficits occur under high levels of stress. The model of stress and athletic injury emphasises the application of interventions aimed at reducing the attentional effects of the stress response. The anxiety management program in the present study could lead to reductions in the risk of injury, as well as life stress, by enhancing central and peripheral visual attention in physically and psychologically stressful conditions. There has been little research done in examining the effects of stress management on physiological and psychological aspects of stress in sport. Future research needs to examine the effect of a stress management program for life stress, anxiety, attentional and physiological changes, particularly, narrowing of the visual field, and general muscle tension, that occur during the stress response in athletic situations. Future research, also should test the effect of a stress management program aimed at reducing injury risk. This study found that stress does affect attentional deficits, so it is necessary to monitor stress in conditions where accidents and injuries are likely in sport and in other areas like driving and working machinery. Further it was shown that such stress and its effects on visual attention, can be moderated by a simple, effective stress management technique.

Chapter 6: Discussion

Introduction

The purpose of the present thesis was to test a part of the Andersen and Williams (1988) model of stress and injury. This discussion section briefly summarises, the main conclusions from the three studies that were undertaken and relates the present results to theory and previous research. Methodological issues raised by the thesis and implications for future research and practice are then considered. Finally, concluding remarks are presented.

Summary of Main Conclusions

The first study reported a substantial incidence of injury in a range of contact sports. The most common type of injury was muscle strain (25.1%), and the most frequent location of injury was ankles (18.9%). The incidence of injury was related to negative life stress, such that higher levels of negative life stress were associated with greater incidence of injury. Further, higher levels of negative life stress were found for injuries where three to nine days were missed than for no missed practice and competition. The results were consistent with other studies. These results were viewed with caution because injuries and life stress had been assessed retrospectively, but it was noted that higher levels of life stress were found for three to nine days missed than for ten or more days injured..

Because the accumulated evidence, including that from the first study and the Kerr and Minden (1988) retrospective study, and that from a number of prospective studies, provided clear support for the relationship between stress and injury, the focus of the remainder of the thesis was on underlying mechanisms, more specifically the role of attention and perception. The purpose of the second study was to examine central and peripheral attentional processing during situations varying in objective physical and psychological stress and how responses to stress were related to life stress, coping skills, and social support. Specifically, the study aimed to examine the effects of stress on visual attention within a laboratory setting. It was found that the participants showed greater attentional deficits under stressful conditions, and that both peripheral errors and response time increased as objective stress was raised by noise and physical activity. The results indicated that the highest level of imposed objective stress, created by combining the effects of noise and physical activity, produced a greater effect on errors and response times than the moderate levels, created by imposing each stressor individually. There was also an increase in errors and response times as peripheral angle increased. The objective stress was a major variable in participants failing to pick up important cues centrally and peripherally. Changes in visual processing under stressful conditions could result in injury to athletes. These results provide support for the attentional aspect of the Andersen and Williams (1988) model, which proposed that an elevated stress response would lead to attentional disruptions (narrowing of the visual field and increased distractibility). This study did not statistically support the existence of a relationship between psychosocial variables (life stress, coping skills, and social support) and central and peripheral error and response time. Negative and positive combined life stress, however, accounted for 15% of the variance in central errors, and negative life stress accounted for 18% of the variance in peripheral response times. These are noteworthy findings in terms of variance accounted for. The small sample size and the use of inappropriate psychosocial measures probably led to these patterns not attaining statistical significance.

The purpose of the third study was to conduct another test of the effects of stress on central and peripheral visual attention under similar conditions to Study 2, and to investigate the effectiveness of an anxiety management program for reducing the stress response. The effect of the anxiety management program on visual attention and perception changes under stress was also examined. This study produced pre-intervention results that supported the second study, there being increased errors and response time under stressful conditions compared to the baseline condition, both errors and response timeincreasing as level of stress and peripheral angle increased. The post-intervention gain score results showed that, under the stressful conditions, as created by physical and physical plus psychological (noise) stress, participants in the AT anxiety management group reduced response time in detection of signals for the central and peripheral task, compared to the control group. These effects increased for larger peripheral angles. Also, in this study, a significant reduction in state anxiety from pre- to post-intervention was observed for the anxiety management treatment group compared to the control group. This indicated that the AT used as the anxiety management program in this study did significantly reduce state anxiety levels, and central and peripheral response times. There was no significant effect of the AT anxiety management program on errors in central and peripheral visual attention. These results may have been due to the very small number of total errors at the pre-intervention stage under even the most stressful conditions, making it difficult to detect any trends from pre- to post-intervention.

Relationship to Theory and Research

The results of the first study, that investigated the relationship between life stress and the occurrence of athletic injury, are consistent with past research (Andersen & Williams, 1988; 1997; Blackwell & McCullagh, 1990; Cryan & Alles, 1983; Hardy, Richman, & Rosenfeld, 1991; Passer & Seese, 1983; Smith et al., 1990; Summers, Fawkner, & McMurray, 1993). Andersen and Williams (1988) proposed that a person's history of stressors (e.g., life events, daily hassles), personality (e.g., hardiness, competitive trait anxiety), coping resources (e.g., social support system, stress management, and mental skills) are important antecedents of athletic injury, when an athlete is in a stressful situation. Andersen and Williams (1997) found that individuals with more negative life events during stress incurred more injuries than those with the opposite profile. Also, Blackwell and McCullagh (1990) reported that football players who experienced high life stress were more likely to incur injury than athletes who experienced low life stress. Study 1 in the present thesis also found a clear relationship between life stress and sports injury in a sample of contact sport participants.

The weakness of the retrospective design, employed in this study, has been noted by Hanson, McCullagh, and Tonymon (1992). When a person is asked, at the same time, to recall their injuries and their stress levels, there is a tendency for the recall of the two to influence each other. It is, in any event, likely that injury leads to an increase in life stress. To determine unequivocally whether life stress affects injury, it is necessary to measure life stress and then monitor injury in the ensuing period.

Recent research has highlighted the more complex nature of the relationship between psychosocial variables and sports injury. In a review and minor revision of their model, Williams and Andersen (in press) have noted that personality and coping resource variables can have either direct or moderating effects on stress. Some studies have found that personality variables including competitive trait anxiety and coping resource variables like social support or coping skills are directly linked to vulnerability to injury (Blackwell & McCullagh, 1990; Williams et al., 1986). Others have found that competitive trait anxiety, social support, and coping skills do not directly affect the incidence of injury, but they moderate the level of life stress experienced, so that lower life stress, associated with strong coping skills or substantial social support, for example, is linked to reduced injury vulnerability. In some situations an effect on life stress has only been found when a combination of moderators all affect the predictor variable, life stress, in specific ways (Petrie, 1993a; Smith et al, 1990). Smith et al. (1990) have called this type of situation, when a set of variables must all be present at specific levels, to influence the relationship between a predictor variable and a criterion variable, conjunctive moderation. The influence of a moderator on the predictor variable, such as life stress, on its own, that is independently, Smith et al. term disjunctive moderation. The design of the present study did not permit the examination of direct versus moderating effects or conjunctive versus disjunctive moderation. As Williams and Andersen (in press) note, the evidence for these complex relationships in the psychosocial stress and sports injury field is mounting.

The results of the second study, that greater peripheral narrowing and attentional deficits were observed during stressful conditions, are consistent with past research (Andersen & Williams, 1997; Hockey, 1970; Kahneman, 1973; Williams & Andersen, 1997; Williams et al., 1990, 1991). According to a study by Williams and Andersen (1997), participants with higher negative life events scores experienced greater peripheral narrowing and slower central vision reaction time during stress than participants with low life events scores. They used, during the demanding task condition, a loud verbal noise played through headphones into one ear and distracting white noise overlaid with the Stroop random colour names into the other ear, to examine the relationship between peripheral narrowing and error. The present study used an additional stress factor, created by physical activity, but only used white noise into both ears as a psychological stressor. The physical activity stressor imitated more closely stress conditions in sport, but the single, colourless noise stressor was less realistic. The results of the present study showed that a combination of stressors, noise and physical activity, lead to greater effects on errors and response times than each did individually. The results of Study 2 are not consistent with past research that reported a significant relationship between life stress and peripheral narrowing (Williams & Andersen, 1997; Williams et al., 1990, 1991). According to a study by Williams et al. (1991), high negative life stress lead to significantly greater peripheral narrowing than low negative life stress. Williams and Andersen (1997) also reported that there was a direct effect of negative life stress on peripheral narrowing.

Although statistical significance was not achieved for the influence of psychosocial variables on central and peripheral error and response time, the multiple regression analyses indicated that life stress explained a substantial amount of the variance in attentional narrowing. The most obvious explanation for the absence of statistically significant effects of life stress variables as predictors in the multiple regression analyses here is that they are due to the relatively small number of participants and subsequent low power of the study. With a larger sample size statistical significance could be obtained. Also, the lack of significant relationship between the psychosocial variables and attentional deficits may be attributed to the use of American college athlete measures with Australian university sports performers, who were neither highly committed athletes, nor independent adults. Their scores on the ALES, ACSI, and SSQ-S showed low variance, reflecting low levels of positive and negative life event stress, adequate coping resources, and substantial satisfaction with social support. For strong relationships to emerge from regression analysis, there would need to be greater variance in the psychosocial variables. Further research, using psychosocial measures that discriminate for the specific sample to be studied and testing larger numbers of sports performers is warranted.

Nonetheless, the study provided strong support for the prediction that stressful conditions affect attentional processes associated with central and peripheral visual attention. The effect for peripheral attention was clearly predicted in the

Andersen and Williams (1988) model. The central visual attention effect is predicted in a recent review and revision of the stress-injury model (Williams & Andersen, in press). The role of psychosocial variables in this process was less clearly demonstrated, but was, nonetheless, supported by the amount of variance that they accounted for.

The results of the third study are consistent with past research that has shown a relationship between stress, anxiety, and attentional deficits (Andersen & Williams, 1997; Williams & Andersen, 1997; Williams et al., 1990, 1991), and research that has demonstrated the effects of stress management programs (Kerr & Goss, 1996). The pre-test results also supported Study 2. The results showed that, under the stressful conditions, participants had significantly greater errors and response time in detection of signals from the central and peripheral task, which increased for larger peripheral angles, than participants in the baseline condition. The Andersen and Williams (1988) model of stress and injury predicts that interventions will reduce the magnitude of physiological/attentional changes associated with the stress response. Davis (1991) and Kerr and Goss (1996), in their studies, supported the link between stress management and reduction of the incidence of injury, proposed by the Andersen and Williams (1988) model. They did not, however, address the issue of the mechanisms involved. By examining the effect of an anxiety management intervention on visual attention under varying levels of stress, this study did consider one of the main mechanisms proposed by Andersen and Williams (1988). The results clearly demonstrated that the deficits in visual attention imposed by the stressors were reduced, at least for response time, as a consequence of the AT program. The absence of significant effects for errors can be attributed to the small number of errors produced at the pre-intervention stage, which left little margin for reduction by a statistically significant extent by the post-intervention stage. Because this was not a sport study, it was not possible to link the effects of stress or the stress management effects on central and peripheral vision directly to the incidence of injury. Andersen and Williams (1997) provide the only published report of a study where laboratory stress effect on attentional processes, linked to psychosocial variables, were then shown to relate to actual injuries in ensuing competition. There is a need for further studies to replicate this crucial link in the stress-injury model. The results of the third study suggest that anxiety management intervention can reduce the effects of stress on attentional processes, as predicted by the Andersen and Williams model. Neither muscle tension, nor cognitive appraisal was examined in this study.

Methodological Issues

The ALES, ACSI, and SSQ life stress questionnaires that were used in Study 1 were effective in that study because the participants in Study 1 were highly committed competitive athletes, similar in those respects to US samples with whom these scales were developed. The same questionnaires were used in Study 2, but here the participants were university students, who were not typically high level, scholarship athletes, with the associated demands, so it is likely that they had not experienced the same level of life stress or the same need for great use of coping resources, as the US scholarship athletes. The participants in Study 2 typically had moderate levels of coping skills, and who received good social support from family and friends, according to their mean scores on the ACSI and the SSQ respectively.

The use of American athletic life stress, coping skills, and social support questionnaires might have contributed to the lack of variability found in the life stress, coping skills, and social support data for this sample. It is probably the case that the sample was homogeneous with respect to these stress and coping resource variables and Australian university students do not represent a fruitful population for such life stress-injury or life stress-attention research, which would be more effective with samples from serious competitive sport in Australia.

For testing central and peripheral visual attention in Studies 2 and 3, a modified perimeter was built. Initially, a pilot perimeter was built and tested to determine its efficacy. As the pilot was successful, an improved machine was designed and built especially for this research. The refined perimeter was effective in the second and third studies. As noted above, different methods were used to measure the central, as opposed to peripheral, response times. Because of different modalities being employed (voice versus motor response mechanisms), the central and peripheral response times in each of these studies (Studies 2 and 3) cannot be compared directly. There was no evidence of participants adopting a speed error trade-off (SET-Off) strategy (Magill, 1985). In each study, errors and response time both increased as conditions became more stressful. This was especially evident for peripheral responses and there were larger effects for response time than for errors. The number of errors was so low in Study 3, that there was not sufficient capacity available for the AT anxiety management program to reduce them significantly. In pilot work, a balance had to be found where participants were not placed under such high levels of stress, by the demands of the task itself, that their performance broke down as soon as external sources of physical and psychological stress were introduced. The results of pilot work indicated that making the task much more demanding did produce this outcome. Thus, the decision was made to employ the parameters used in Studies 2 and 3, accepting relatively low levels of error in detection, with clear deficits in response time.

It should be noted that the nature of the central task and the peripheral task were different from those employed by Williams and her colleagues (1990, 1991, 1997) in the only comparable studies to those reported here. First, Williams and her colleagues used the Stroop colour test as the central task. This is in itself a stressful task, much more demanding that simply identifying whether a light has illuminated in central vision, as employed here. Nonetheless, the present study did find significant changes in central task performance under stressful conditions, even for this very simple stimulus-response task. Williams and her colleagues used a light moving in from the periphery as their peripheral task, measuring response time, which corresponded to the time elapsed, and thus the angle attained, from initiation of the trial. Response time in the current study referred to time elapsed before identification of illumination of stationary lights at different peripheral angles. Despite the static/dynamic difference between stimuli in the present and the previous studies, the results are consistent: as stress increases, response time slows down in the periphery, more so as peripheral angle increases. A disadvantage of the present approach is that cues in peripheral vision in sports are usually moving, so the dynamic design has greater ecological validity. The use of static stimuli at varying angles in the present study did lead to the consistent finding that errors and response time increased as peripheral angle increased. This suggests that the effect is not due to a simple peripheral narrowing process. An all-or-none peripheral narrowing process would show a loss of all stimuli at wider angles with minimal or no loss at all shallower angles. Since, in Study 2 at least, experimental conditions were not highly distracting, using only white noise at moderate levels, the reduced attentional processing at shallower peripheral angles is unlikely to be accounted for by attention distraction. A central reduction in attentional resource allocation might provide a clearer explanation of the present results. Further testing of the attentional narrowing, distraction, and resource allocation processes is warranted. The use of static stimuli made the observation possible.

Between Studies 2 and 3, the number of stress conditions was reduced. Four levels of stress were used in Study 2, but the noise only condition did not reflect a noteworthy difference from the baseline condition. The combination of physical activity and noise did affect the results, producing significantly higher levels of error and response time than physical activity alone or noise alone, and is more like a real sporting game. The type of noise was changed from white noise in Study 2 to crowd noise in Study 3. White noise produced a negative effect when combined with physical activity in Study 2, but the possibility exists that white noise may result in effects of habituation, if conditions continued for substantial periods. To avoid this, crowd noise was used instead of white noise in Study 3. White noise does not involve distracting content, so any effect it produces can be attributed to a central psychological stress effect on attention. Effects due to crowd noise can not be attributed to a psychological stress effect per se, as they might result from attentional distraction related to the content of the noise. Nevertheless, such noise is more typical of competitive sport environments. Together, the effect of white noise, in the physical activity/noise condition, in Study 2 and of crowd noise, in the same condition, in Study 3, do suggest that there is a psychological stress effect, which might be exacerbated by increased distractibility. Comparing the effects found in Study 2 and the pre-intervention phase of Study 3 here, with the previous work of Williams and her colleagues, it is clear that the extent of the psychological stress imposed was much greater in the previous work. Although Williams and her colleagues do not report the intensity of the noise in decibels, a loud crowd noise in one ear and white noise plus Stroop colour words in the other ear, does seem to constitute a greater level of stressors than the 95 decibel white noise in Study 2 to both ears or the 83-95 decibel crowd noise to both ears in Study 3. What is of interest in comparing Studies 2 and 3 with the previous work is that the inclusion of physical activity here appeared to add a degree of stress that produced equivalent patterns of decrement in the central and peripheral tasks to those found by Williams and her colleagues. Further work using physical as well as psychological stressors is certainly warranted, as many sports do involve moderate to intense physical activity, often with physical contact, so the influence of this type of stressor needs to be fully explored.

In Studies 2 and 3, the peripheral targets were presented in four angular ranges, 60°-70°,71°-80°, 81°-90°, and 91°-100°. The 60°-70° angle results differed little from the 71°-80° range, so, in Study 3, the 60°-70° range was omitted to simplify the analyses, with no detriment to the research, there still being clear differences between the 71°-80°, 81°-90°, and 91°-100° ranges, and the effects at the wider peripheral angles were of greatest interest. Whereas the principal conclusion from the finding for peripheral angle was that greater slowing of response time and more errors occurred at the wider angles as the level of stress increased, it is worthy of note that there was a decrement at angles as shallow, relatively, as 60 degrees. High levels of stress are associated with increased risk of error and thus injury over much of the visual field.

In the third study, AT was used as the anxiety management program. The AT program used was a modified version of the procedure developed by Schultz and Luthe (1959). In the original approach of Schultz and Luthe, the stages progressed slowly. For example, session 1 might involve only the statement "my right arm is heavy", session 2 the statement "my right arm is heavy; my left arm is heavy" and so on. Davis, Eshelman, and McKay (1995), for example, describe a 12 week program, with limb heaviness the focus for weeks 1 to 3, limb warmth added to heaviness over weeks 4 to 7, and the heartbeat, breathing, solar plexus, and forehead themes introduced in weeks 8 to 11 respectively. Week 12 was proposed to introduce special themes. In the AT protocol used in Study 3, all the stages were introduced in the first session and repeated in every session that followed (as illustrated in Appendix J). These statements were then practised and repeated for the whole of the intervention period. From the results, it appears that the much shorter modified AT process was effective in reducing anxiety levels and it was much quicker to learn than the full procedure. The full procedure might have discouraged participants, had it been used, because of the slow progression of stages.

To determine if certain conditions were more stressful, psychophysiological measures could be used. There are many physiological changes that occur during stressful conditions, but increases in generalised muscle tension may be one of the main factors influencing injury likelihood. Unfortunately, only one study has examined the relationship between psychosocial factors and physiological changes, such as increased general muscle tension, under low and high stress conditions (Andersen, 1988). Andersen found that the total group exhibited increased muscle tension during the stress condition. To determine psychophysiological changes due to stress, future research should not only examine the attentional aspects (e.g., error and response time), but also physiological changes, such as general muscle tension, using electromyography (EMG) measures taken during the stressful conditions.

The approach used in this thesis showed a logical progression: the relationship between life stress and athletic injury was examined in Study 1, the effect of stress on visual attention within a laboratory setting was considered in Study 2, and the effectiveness of an anxiety management program for reducing the anxiety response, as well as the effect of such reduction on visual attention under stressful conditions, were investigated in Study 3. Overall, the research methods used in this thesis were effective in exploring these issues, although the retrospective design of Study 1 should not be repeated and care needs to be taken in the selection of psychometric measures to suit the population being studied. The similarity of findings to those of previous studies, but using a different population, different stressors, and different stimulus and response conditions suggests that the stress-injury effects are relatively robust.

Implications for Future Research

To understand the stress-injury relationship more precisely and to refine selection of appropriate stress management techniques, the priority must be to continue to study the mechanisms underlying the stress and injury relationship. Future research should further develop understanding of the mechanisms proposed in the Andersen and Williams (1988) stress and athletic injury model and specify the ways in which those mechanisms relate to the techniques used for management of stress to help reduce the incidence of injury. For example, although the third study in this thesis demonstrated that AT was an effective technique for the reduction of state anxiety and the moderation of the effects of physical and psychological stressors on attention, there might be other techniques that are more efficacious in this respect. It is not presently clear whether the effect of stress on attention is largely due to bodily/somatic stress effects or cognitive stress effects. Further investigation of this issue could lead to more precision in the prescription of stress management techniques, that is, somatic techniques, such as relaxation or breathing, would be appropriate interventions if the effect of stress is somatic, whereas cognitive techniques, such as thought stopping or rational thinking, are more suited to managing the stress, if it is largely cognitive. Further, because no measures of psychophysiological function, especially muscle tension levels, were monitored in the present thesis, it is not clear to what extent stress affected tension relative to attention, nor is there evidence that indicates whether AT reduced muscle tension. This could be investigated by using the present paradigm and measuring muscle tension, as well as attention, at pre-intervention and at post-intervention, when a number of stress management techniques with different proposed effects are used as interventions. It is possible, in fact likely, given research on cognitive and somatic anxiety in sport (see Martens, Vealey, & Burton, 1990, for a review) that cognitive and somatic effects will both be found in different combinations in the same person in different situations and varying between situations. Stress management interventions are likely to be more effective when the influence of various psychosocial and situational variables is determined.

Although the second and third studies in this thesis supported the link between stress and attention in the Andersen and Williams (1988) model, it was not clear what aspects of the physical and psychological stressors were responsible for the deterioration of visual attention. Future research should examine different types of stressor to clarify what aspects of various types of stressors affect attention. Studies 2 and 3 have not shown what mechanism or mechanisms of attention is affected by those stressors. Future research needs to examine attentional narrowing, distractibility, and allocation of resources, because, the studies in the present thesis suggest that the effect is not only an attentional narrowing effect, but they do not discount a role for attentional narrowing. The central task was disrupted and so was shallow peripheral visual attention, which are not usually considered to be attentional narrowing effects, although neither was affected as much as wide peripheral attention, which could implicate attentional narrowing.

The second study showed that, for that sample, in the present context, psychosocial variables did not disrupt attention to a statistically significant level. Life stress did, however, account for substantial variance. This suggests that the small number of participants, low power, and the specific groups or types of people involved in that study might not have been adequate to demonstrate significant psychosocial effects on stress, because the life stress of those participants was typically low, with high social support, and adequate to good coping resources. It is important for future research to use a large enough number of participants to have adequate power, and to use sensitive measures that identify those who are likely to experience levels of psychosocial variables that could lead to increased injury incidence.

The development of more ecologically valid tasks might enhance future studies, especially where committed athletes, rather than college students act as participants. For example, if studies involved team game players, the central task could be a tachistoscopically presented task with still photos or a video-based decision task from the sport in which the participants are involved and the peripheral task could involve images from that sport, such as photographs of team-mates or opponents, dressed in the relevant colours. These could either be flashed on at different locations in the periphery or they could move in from the periphery at a constant rate. The increased meaningfulness of such designs could help to refine the relationship between psychosocial variables, stress, and attentional processes. It would also be possible to examine more subtle issues, such as deciding whether a static or dynamic cue in the periphery is a teammate or an opponent.

Another, more theoretical, issue that is raised by the present thesis concerns the specific aspect of the stressors that was responsible for their joint effect. In both Study 2 and Study 3, the combination of the physical stressor (physical activity), and the psychological stressor (noise), produced the largest number of errors and the longest response times. It is not clear whether this was simply because the combination of different stressors is more stressful than a single source of stress, or whether it is because the stressors were different in kind, one being a physical stressor and the other a psychological stressor. Further research is needed that compares combinations of physical stressors, as well as combinations of psychological stressors, with combinations of physical and psychological stressors. Further, these could be compared with high levels of single stressors, both physical and psychological, to determine whether certain combinations are more disruptive because of the combination per se, rather than because of the overall level of stress induced by the stressors in that combination. While it is important to conduct applied research that is ecologically valid, that is, research that creates situations as closely related to the real sport context as we can construct, studies that aim to enhance understanding of underlying psychological processes can lead to the identification of widely applicable principles. Both types of research are needed.

The results of the studies undertaken in this thesis, especially Studies 2 and 3, raise a range of exciting questions for further research. As noted, these include examining more closely those aspects of a stressor(s) that affect attention and injury incidence, considering the effects of different types of stressor on attentional mechanisms and muscular tension, and investigating the efficacy of various stress management techniques for managing the different sorts of stress. It should be emphasised, however, that the present studies are, on their own, not enough to present a conclusive argument. There is still the need to replicate these studies, particularly with different kinds of sport and various types of performer. At the same time, the combined results of the second study and the pre-test data from Study 3 were noteworthy for their similarity, when different types of noise were used as the psychological stressor.

Two other issues deserve greater attention in future research. Although the evidence is accumulating to support the proposition of the stress-injury model that life stress, combined with acute stress, under certain conditions of moderator personality and coping variables is related to increased stress responsivity in terms of attentional deficits, there is very little research that has tested the prediction that such attentional deficits are linked to increased incidence of injury. In a recent study, Andersen and Williams (1997) showed attentional disruption of those high on psychosocial variables in a stressful, laboratory setting and then followed the same athletes during the ensuing season. They found that those who showed greater attentional disruption in the laboratory task did have a higher incidence of injury than other participants in the study. More research of this nature must be carried out to confirm that element of the stress-injury model.

Secondly, while attention has been the most attractive mechanism for researchers to examine to date, there is little research on the role of muscle tension. Andersen (1988) found that generalised muscle tension can lead to the athlete experiencing fatigue, and a decrease in flexibility, and muscle efficiency. More research on the relationship of muscle tension to vulnerability to injury is particularly needed. Perhaps the least considered aspect of the stress responsivity section of the stress-injury model, however, is cognitive appraisal. Not only has this component been ignored by researchers, as a mechanism, the potential for managing stress and reducing injury by interventions that are designed to affect cognitive appraisal has not been examined. There would seem to be great potential for studies that measure and intervene to change cognitive appraisal, and such research would be valuable testing the model.

In a timely review of research that relates to their stress-injury model, Williams and Andersen (in press) have added several relationships to be original model. They note that history of stressor variables can influence certain personality and coping resource variables are signified by two-directional arrows in the revised version of the model. Similarly, personality and coping resource variables can influence each other, so a bi-directional link has been added between these categories. These modifications should stimulate further research to clarify the complex relationships between the psychosocial components of the model, recognising the sophisticated contingencies which will often exist. For example, previous injury has some direct effects on stress reactivity, but it might also have provided an opportunity to develop effective coping skills or sensitised the person to the need to access appropriate social support in future. Much research is still needed to examine such issues fully. Qualitative methods would enhance appreciation of the richness of these interconnections.

Implications for Future Practice

The research in this thesis has shown that physical activity and noise have effects on attention in a laboratory task involving central and peripheral signals. It is likely that the effect would be more potent in complex sports where physical activity and noise are at greater levels than in the laboratory. Thus, sport psychology practice needs to examine the efficacy of a wide range of existing techniques to moderate the effects of such stressors. Greater knowledge of the mechanisms by which stress influences the incidence of injury should make it possible to predict which interventions are most efficacious on theoretical grounds. Taking part in an experiment can be quite stressful in itself, but being a participant in Study 2 or 3 in the present thesis would not have created as much stress as most sport competition. Therefore, there is likely to be a range of stresses to manage, that will add to the overall stress effect in competition.

The present thesis has demonstrated the powerful effects of stressors on attention, effects that could lead to decrements in performance, as well as increased incidence of injury. Research should continue into the ways in which stress affects attention and, hence, performance and injury. Practitioners also need to recognise that stressors do have such effects and to consider the sorts of techniques at their disposal to help athletes cope with a range of stressors. In addition to those stressors that are imposed by the sport itself, there is little doubt that high levels of life stress need to be taken into account, even though this was not unequivocally evident in Study 2 here, nor tested for in Study 3. Training in coping skills to help manage the effects of the cumulative small hassles, as well as the major life events that create stress, along with the provision of and training in social support to help in coping seem to be appropriate ways to try to minimise the effects of such stressors. The mutual interests of practitioners and researchers should encourage them to collaborate in developing effective methods of managing stress in the often highly volatile arena of competitive sport. The evidence is growing that all of these approaches have the potential to reduce vulnerability to injury in sport at all levels.

Concluding Remarks

Results of the present thesis provide support for part of the Andersen and Williams (1988) model of stress and athletic injury. The first study examined the relationship between life stress and athletic injury, and found that injured athletes had higher negative life stress than athletes who were not injured. The second study examined the effect of stress and psychosocial factors on visual attention. Results indicated that participants in the stress conditions had greater attentional deficits, and that both errors and response time increased as objective stress was raised by noise and physical activity. This study, however, did not statistically support the existence of a relationship between psychosocial variables and attentional narrowing. Although statistical significance was not achieved, the multiple regression analyses indicated that life stress explained a substaintial amount of the variance in attentional narrowing. The model of stress and athletic injury emphasises the application of interventions aimed at reducing the attentional deficits associated with the stress response. Interventions like the anxiety management program in Study 3 could lead to reductions in the risk of injury. Such interventions can reduce the effects of life events on stress levels, enhancing central and peripheral visual attention in physically and psychologically stressful conditions. Thus, while further work is needed to replicate this research, the present thesis has developed and used a paradigm, namely the examination of interventions to moderate the effects of life stress on attention, that could be widely applied to address the issues associated with the effects of stress in sport, especially with reference to injury. There is much to understand still in the way that certain stressors might affect visual or other forms of attention and how various interventions might reduce the effects of those stressors.

There is enough evidence that stress does influence attention, from the present results and those of Williams and Andersen (1997), and Williams et al. (1990, 1991), to warrant exploration of the effects of interventions, which aim to reduce stress and its effects on visual attention. There was a very clear deterioration of attention seen here, under relatively moderate levels of experimentally induced stress. This suggests that the potential for injury due to attentional deficits under the much higher levels of stress and in the more complex task environments of many competitive sports is likely to be great. Thus, the identification of effective interventions, that moderate these attentional effects must be a priority. It is hoped that the work reported in this thesis will support the ongoing efforts of Williams and her colleagues, in stimulating more researchers to address the many aspects of the complex stress-injury relationship.

References

Albrecht, R. A., & Feltz, D. L. (1987). Generality and specificity of attention related to competitive anxiety and sport performance. Journal of Sport and Exercise Psychology, 9, 231-248.

Allen, R. J., & Hyde, D. (1981). Investigations in stress control. Minneapolis: Burgess.

Andersen, M. B. (1988). Psychosocial factors and changes in peripheral vision, muscle tension, and fine motor skills during stress. Unpublished doctoral dissertation, University of Arizona, Tucson, AZ.

Andersen, M. B., & Williams, J. M. (1988). A model of stress and athletic injury: Prediction and prevention. Journal of Sport and Exercise Psychology, 10, 294-306.

Andersen, M. B., & Williams, J. M. (1993). Psychological risk factors: Injury prediction and preventative measures. In J. Heil (Ed.), Psychology of sport injury. Champaign, IL: Human Kinetics.

Andersen, M. B., & Williams, J. M. (1997). Athletic injury, psychosocial factors, and perceptual changes during stress. Manuscript submitted for publication.

Appley, M. M., & Trumbull, R. (1967). On the concept of psychological stress. In M. M. Appley & R. Trumbull (Eds.), Psychological stress, (pp. 128-131). New York: Appleton.

Astrand, P., & Rodahl, N. T. (1977). Textbook of work physiology. New York: McGraw-Hill.

Australian Sports Commission (1993). Sport: a great investment. Canberra: Australian Sports Commission.

Barker, H. B., Beynnon, B. D., & Renstrom, P. A. (1997). Angle injury risk factors in sports. Sports Medicine, 23, 69-74.

Benson, H. (1975). The relaxation response. New York; Avon.

Bergandi, T. A., & Wittig, A. F. (1988). Attentional style as a predictor of athletic injury. International Journal of Sport Psychology, 19, 226-235.

Blackwell, B., & McCullagh, P. (1990). The relationship of athletic injury to life stress, competitive anxiety, and coping resources. Athletic Training, 25, 23-27.

Bond, J. W., Miller, B. P., & Chrisfield, P. M. (1988). Psychological prediction of injury in elite swimmers. International Journal of Sports Medicine, 9, 345-348.

Bramwell, S. T., Masuda, M., Wagner, N. N., & Holmes,T. H. (1975). Psychological factors in athletic injuries: Development and application of the Social and Athletic Readjustment Rating Scale (SARRS). Journal of Human Stress, 1, 6-20.

Brewer, B. W., Jeeffers, K. E., Petitpas, A. J., & Van Raalte, J. L. (1994). Perceptions of psychological interventions in the context of sport injury rehabilitation. The Sport Psychologist, 8, 176-188.

Broadbent, D. E. (1954). Some effects of noise on visual performance. Quarterly Journal of Experimental Psychology, 6, 1-15.

Brock, R., & Striowski, C. (1986). Injuries in elite figure skaters. Physician and Sports Medicine, 14, 111-115.

Brown, S. D., Brady, T., Lent, R. W., Wolfert, J., & Hall, S. (1987). Perceived social support among college students: Three studies of the psychometric characteristics and counseling uses of the Social Support Inventory. Journal of Counseling Psychology, 34, 337-354.

Burks, N., & Martin, B. (1985). Everyday problems and life change events: On-going versus acute sources of stress. Journal of Human Stress, 11, 27-35.

Burns, W. (1979). Physiological effect of noise. In C. M. Harris (Ed.), Handbook of noise control. New York: McGraw-Hill.

Bursill, A. E. (1958). Restriction of peripheral vision during exposure to hot and humid conditions. Quarterly Journal of Experimental Psychology, 10, 113-129.

Byrd, B.J. (1993). The relationship of history of stressors, personality, and coping resources, with the incidence of athletic injuries. Unpublished master's thesis, University of Colorado, Boulder.

Cannon, W. B. (1932). Bodily changes in pain, hunger, fear, and race. New York: Appleton.

Cattell, R. B., Eber, H. W., & Tatsuoka, M. M. (1974). Handbook for the Sixteen Personality Factor Questionnaire. Champaign, IL: Institute for Personality and Ability Testing.

Cauce, A. M., Felner, R. D., & Primavera, J. (1982). Social support in high-risk adolescents: Structural components and adaptive impact. American Journal of Community Psychology, 10, 417-428.

Chang-Liang, R., & Denney, D. R. (1976). Applied relaxation as training in self-control. Journal of Counseling Psychology, 23, 183-189.

Coddington, R. D., & Troxell, J. R. (1980). The effect of emotional factors on football injury rates: A pilot study. Journal of Human Stress, 6, 3-5.

Compas, B. E., Davis, G. E., Forsythe, C. J., & Wagner, B. (1987). Assessment of major and daily stressful events during adolescence: The Adolescent Perceived Events Scale. Journal of Consulting and Clinical Psychology, 55, 534-541.

Coopersmith, S. (1967). The antecedents of self-esteem. San Francisco: W.H. Freeman.

Cox, R. H. (1990). Sport psychology: Concepts and applications. Dubuque, IA: Wm. C. Brown.

Crocker, P. R. E., & Gordon, S. (1986). Emotional control training for soccer. In J. Watkins, T. Reilly & L. Burwitz (Eds.), Sport Science. New York: E. & F.N. Spon.

Crocker, P. R. E., & Graham, T. R. (1995). Coping by competitive athletes with performance stress: Gender differences and relationships with affect. The Sport Psychologist, 9, 325-338.

Crossman, J. (1997). Psychological rehabilitation from sports injuries. Sports Medicine, 23, 333-339.

Cryan, P. O., & Alles, E. F. (1983). The relationship between stress and football injuries. Journal of Sports Medicine and Physical Fitness, 23, 52-58.

Cunningham, C., & Cunningham, S. (1996). Injury surveillance at a national multi-sport event. The Australian Journal of Science and Medicine in Sport, 28, 50-56.

Dalhauser, M., & Thomas, M. B. (1979). Visual disembedding and locus of control as variables associated with high school football injuries. Perceptual and Motor Skills, 49, 254.

Davis, J. O. (1991). Sports injuries and stress management: An opportunity for research. The Sport Psychologist, 5, 175-182.

Davis, M., Eshelman, E. R., & McKay, M. (1995). The relaxation and stress reduction workbook. Oakland: New Harbinger Publications.

DeLongis, A., Coyne, J. C., Dakof, G., Folkman, S., & Lazarus, R. S. (1982). Relationship of daily hassles, uplifts, and major life events to health status. Health Psychology, 1, 119-136.

DeLongis, A., Folkman, S., & Lazarus, R. S. (1988). The impact of daily stress on health and mood: Psychological and social resources as mediators. Journal of Personality and Social Psychology, 54, 486-495.

Durso-Cupal, D. D. (1996). The efficacy of guided imagery for recovery from anterior cruciate ligament (ACL) replacement. Journal of Applied Sport Psychology (AAASP Abstracts), 8, 556.

Eldridge, W. D. (1983). The importance of psychotherapy for athletic related orthopedic injuries among adults. International Journal of Sport Psychology, 14, 203-211.

Easterbrook, J. A. (1959). The effect of emotion on cue utilisation and organisation of behaviour. Psychological Review, 66, 183-201.

Eschenbrenner, J. A. (1971). Effects of intermittent noise on the performance of a complex psychomotor task. Human Factors, 13, 59-63.

Fawkner, H.J. (1993). Predisposition to injury in athletes: The role of psychosocial factors. Unpublished master's thesis, University of Melbourne, Australia.

Ford, I. W., Eklund, R. C., & Gordon, S. (1997). The moderating effects of social support on the life stress-injury time loss relationships among high level athletes. In R. Lidor & M. Bar-Eli (Eds.), Innovations in sport psychology: Linking theory and practice, Proceedings of the IX World Congress of Sport Psychology (pp. 277-279). Netanya, Israel: Wingate Institute.

Fortunato, V. (1997). Role transitions of elite Australian rules footballers. Unpublished doctoral dissertation, Victoria University of Technology, Australia.

Freese, A. (1976). Understanding stress. New York: Public Affairs Committee Inc.

Garrick, J. G., & Requa, R. K. (1978). Injuries in high school sports. Pediatrics, 61, 465-473.

Gill, D. L. (1994). A sport and exercise psychology perspective on stress. Quest, 46, 20-27.

Goldfried, M. (1971). Systematic densensitization as training in self-control. Journal of Consulting and Clinical Psychology, 37, 228-234.

Goldfried, M., Decenteceo, E. T., & Weinberg, L. (1974). Systematic rational restructuring as a self-control technique. Behavior Therapy, 5, 247-254.

Gordon, S., Milios, D., & Grove, R. (1991). Psychological aspects of the recovery process from sport injury. The Australian Journal of Science and Medicine in Sport, 6, 53-59.

Gould, D. (1987). Promoting positive sport experiences for children. In J. R. May & M. J. Asken (Eds.), Sport psychology: The psychological health of the athlete (pp. 77-98). New York: PMA.

Gould, D., & Krane, V. (1992). The arousal-athletic performance relationship: Current status and future directions. In T. S. Horn (Ed.), Advances in sport psychology (pp. 119-141). Champaign, IL: Human Kinetics.

Gould, D., & Petlichkoff, L. (1987). Psychological stress and the age-group wrestler. In E. W. Brown & C. F. Branta (Eds.), Competitive sports for children and youth: An overview of research and issues (pp. 63-73). Champaign, IL: Human Kinetics.

Gould, D., Petlichkoff, L., Simons, J., & Vevera, M. (1987). Relationship between Competitive State Anxiety Inventory-2 subscale scores and pistol shooting performance. Journal of Sport Psychology, 9, 33-42.

Greenberg, J. S. (1983). Comprehensive stress management. Dubuque, IA: Brown.

Griffiths, P. O. (1970). Noise in the laboratory. Journal of British Medicine, 3, 622.

Hackfort, D., & Schwenkmezger, P. (1993). Psychological characteristics and high level performance. In R. N. Singer, M. Murphy & L. K. Tennant (Eds.), Handbook of research on sport psychology (pp. 328-364). Don Mills, Ontario: Macmillan.

Haney, C. J., & Long, B. C. (1995). Coping effectiveness: A path analysis of self-efficacy, control, coping, and performance in sport competitions. Journal of Applied Social Psychology, 25, 1726-1746.

Hanson, S. J., McCullagh, P., & Tonymon, P. (1992). The relationship of personality characteristics, life stress, and coping resources to athletic injury. Journal of Sport and Exercise Psychology, 14, 262-272.

Hardy, C. J., Richman, J. M., & Rosenfeld, L. B. (1991). The role of social support in the life stress/injury relationship. The Sport Psychologist, 5, 128-139.

Hardy, C. J., & Riehl, R. E. (1988). An examination of the life stress-injury relationship among noncontact sport participants. Behavioral Medicine, 14, 113-118.

Harrington, D. O. (1981). The visual fields: A textbook of clinical permetry. St. Louis: C. V. Mosby.

Harris, C. S. (1972). Effects of intermittent and continuous noise on serial search performance. Perceptual and Motor Skills, 35, 627-634.

Harris, D. D., & Williams, J.M. (1993). Relaxation and energising techniques for regulation of arousal. In J. M. Williams (Ed.), Applied sport psychology: Personal growth to peak performance (pp. 185-199). Mountain View, CA: Mayfield.

Heil, J. (1993). Psychology of sport injury. Champaign, IL: Human Kinetics.

Hockey, G. R. J. (1970). Effect of loud noise on attentional selectivity. Quarterly Journal of Experimental Psychology, 22, 28-36.

Hockey, G. R. J. (1983). Stress and fatigue in human performance. Chichester, England: Wiley & Sons.

Holmes, T.H. (1970). Psychological screening. In Football injuries: Papers presented at a workshop (pp. 211-214). Sponsored by Sub-committee on Athletic Injuries, Committee on the Skeletal System, Division of Medical Sciences, National Research Council, Feb. 1969. Washington, DC: National Academy of Sciences.

Holmes, T. J., & Rahe, R. J. (1967). The social readjustment scale. Journal of Psychosomatic Research, 11, 213-218.

Huck, S. W., & McLean, R. A. (1975). Using a repeated measures ANOVA to analyze the data from a pretest-posttest design: A potentially confusing task. Psychological Bulletin, 82, 511-518.

Hyman, R. (1953). Stimulus information as a determinant of reaction time. Journal of Experimental Psychology, 45, 188-196.

Inklaar, H. (1994). Soccer injuries. Sports Medicine, 18, 55-73.

Jackson, D. W., Jarrett, H., Barley, D., Kausch, J., Swanson, J. J., & Powell, J. W. (1978). Injury prediction in the young athlete. American Journal of Sports Medicine, 6, 6-14.

Jacobson, E. (1930). Progressive relaxation. Chicago: University of Chicago Press.

Jones, D. M. (1983). Noise. In G. R. J. Hockey (Ed.), Stress and fatigue in human performance. Chichester, England: Wiley & Sons.

Jones, G. J., & Hardy, L. (Eds). (1990). Stress and performance in sport. Chichester, England: Wiley & Sons.

Kahneman, D. (1973). Attention and effort. Englewood-Cliffs, NJ: Prentice-Hall.

Kanner, A. D., Coyne, J. C., Schaefer, C., & Lazarus, R. S. (1981). Comparison of two modes of stress measurement; Minor daily hassles and uplifts vs major life events. Journal of Behavioral Medicine, 4, 1-39.

Kaplan, G. D., & Cowles, A. (1978). Health locus of control and health value in the prediction of smoking reduction. Health Education Monographs, 6, 129-137.

Kerr, G., & Cairns, L. (1988). The relationship of selected psychological factors to athletic injury occurrence. Journal of Sport and Exercise Psychology, 10, 167-173.

Kerr, G., & Goss, J. (1996). The effects of a stress management program on injuries and stress levels. Journal of Applied Sport Psychology, 8, 109-117

Kerr, G, & Minden, H. (1988). Psychological factors related to the occurrence of athletic injuries. Journal of Sport and Exercise Psychology, 10, 167-173.

Kogi, K., & Saito, Y. (1973). Rhythmic fluctuation of orientation to a continuous manual control task. Journal of Human Ergonomics, 2, 169-184.

Kolt, G. S., & Kirkby, R. J. (1994). Injury, anxiety, and mood in competitive gymnasts. Perceptual and Motor Skills, 78, 955-962.

Kraus, J. F., & Conroy, C. (1984). Mortality and morbidity from injuries in sport and recreation. Annual Review of Pubic Health, 5, 163-192.

Krestornikov, A. N. (1951). Studies in physiology of physical exercise. Moscow: State Publishing House.

Kryter, K. D. (1970). The effect of noise in man. New York: Academic press.

Landers, D. M. (!980). The arousal-performance relationship revisited. Research Quarterly for Exercise and Sport, 51, 77-90.

Lazarus, R. S. (1966). Psychological stress and the coping process. New York: McGraw-Hill.

Lazarus, R. S. (1974). Psychological stress and coping in adaptation and illness. International Journal of Psychiatry and Medicine, 5, 321-333.

Lazarus, R. S., & Folkman, S. (1984). Stress, appraisal, and coping. New York: Springer.

Leonard, J. A. (1959). Tactual choice reactions. Quarterly Journal of Experimental Psychology, 11, 76-83.

Lewis, F. M., Morisky, D. E., & Flynn, B. S. (1978). A test of construct validity of Health Locus of Control: Effects of self-reported compliance for hypertensive patients. Health Education Monographs, 6, 138-148.

Loeb, M., & Jones, P. D. (1978). Noise exposure, monitoring, and tracking performance as a function of signal bias and task priority. Ergonomics, 21, 265-277.

Long, B. C. (1984). Aerobic conditioning and stress inoculation: A comparison of stress management interventions. Cognitive Therapy and Research, 8, 517-532.

Luthe, W. (1969). Autogenic therapy. New York: Grune and Stratton.

Lynch, G. P. (1988). Athletic injuries and the practicing sport psychologist: Practical guidelines for assisting athletes. The Sport Psychologist, 2, 161-167.

Lysens, R., Auweele, Y. V., & Ostyn, M. (1986). The relationship between psychosocial factors and sports injuries. Journal of Sports Medicine and Physical Fitness, 26, 77-84.

MacDonald, A. P. (1970). Internal-external locus of control and practice of birth control. Psychological Reports, 27, 206.

Mace, R. D., & Carroll, D. (1989). The effects of stress inoculation training on self-reported stress, observer's rating of stress, heart rate, and gymnastic performance. Journal of Sport Science, 7, 257-266.

Mahoney, M. J. (1979). Cognitive skills and athlete performance. In P. Kendall & S. Hollen (Eds.), Cognitive-behavioural interventions: Theory, research and procedures. New York: Academic Press.

Magill, R. A. (1985). Motor learning, concepts and applications. Dubuque, IA: Wm. C. Brown.

Marteniuk, R. G. (1976). Information processing in motor skills. New York: Holt, Rhinehart, & Winston.

Martens, R. (1971). Anxiety and motor behaviour: A review. Journal of Motor Behaviour, 3, 151-179.

Martens, R. (1977). Sport Competition Anxiety Test. Champaign, IL: Human Kinetics.

Martens, R. (1987). Coaches guide to sport psychology. Champaign, IL: Human Kinetics.

Martens, R., & Landers, D. M. (1970). Motor performance under stress: A test of the inverted-U hypothesis. Journal of Personality and Social Psychology, 16, 29-37.

Martens, R., Vealey, R. S., & Burton, D. (1990). Competitive anxiety in sport. Champaign, IL: Human Kinetics.

Matthews, R., & Fox, J. (1976). The Physiological bases of physical education and athletics. Philadelphia: Saunders College.

May, J. R., & Sieb, G. E. (1987). Athletic injuries: Psychological factors in the onset sequelae, rehabilitation, and prevention. In J. R. May & M. J. Asken (Eds.), Sport psychology: The psychological health of the athlete, (pp. 157-185). New York: PMA.

May, J. R., Veach, T. L., Reed, M. W., & Griffey, M. S. (1985). A psychological study of health, injury, and performance in athletes on the U.S. alpine ski team. The Physician and Sports Medicine, 13, 111-115.

May, J. R., Veach, T. L., & Southard, S. W. (1985). The effect of life change on injury, illness and performance in elite athletes. In N. K. Butts, T. G. Gushikin & B. Zarins (Eds.), The elite athlete, (pp. 171-179). Jamaica, NY: Spectrum.

Maynard, I. W., & Howe, B. L. (1987). Interrelations of trait and state anxiety with game performance of rugby players. Perceptual and Motor Skills, 64, 599-602.

McGrath, J. E. (1970). Major methodological issues. In J. E. McGrath (Ed.), Social and psychological factors in stress. New York: Holt, Rinehart, & Winston.

McKay, G. D., Payne, W. R., Goldie, B. W., Oakes, B. W., & Stanley, J. J. (1996). A comparison of the injuries sustained by female basketball and netball players. The Australian Journal of Science and Medicine in Sport, 28, 12-17.

McLatchie, G. R. (1993). Essentials of Sports Medicine. London: Churchill Livingstone.

McLeod, S., & Kirkby, R. J. (1995). Locus of control as a predictor of injury in elite basketball players. Sports Medicine, Training and Rehabilitation, 6, 201-206.

McNair, D., Lorr, M., & Droppleman, L. F. (1971). Profile of Mood States. San Diego: Educational and Industrial Testing Services.

Meichenbaum, D. (1985). Stress inoculation training. New York: Pergamon Press.

Meichenbaum, D., & Turk, D. C. (1976). The cognitive-behavioral management of anxiety, anger, and pain. In P.O. Davidson, (Ed.), The behavioural management of anxiety, depression and pain. New York: Brunner/Mazel.

Miller, L. H., & Smith, A. D. (1982). Stress Audit Questionnaire. Bostonia, 39-54.

Miller, T. W., & Vaughn, M. P. (1986). Psychological stressors and symptom formation in female cross country runners. Colloquium Presentation Department of Mental Health and Behavioural Sciences, VA and University of Kentucky Medical Centres.

Moore, R.A. (1966). Sport and mental health, Springfield, IL: Thomas.

Morgan, W. P., & Ellickson, K. A. (1989). Health anxiety and physical exercise. In D. Hackfort, & C.D. Spielberger (Eds.), Anxiety in sports: An international perspective, New York: Hemisphere Publishing.

Morris, T. (1997). Psychological Skills Training in Sport. Leeds: NCF Publications.

Muangnapoe, P., & Morris, T. (1995). Meditation, relaxation, and multidimensional state anxiety. Proceedings of the AIESEP World Congress., Netanya, Israel: Wingate Institute.

National Collegiate Athletic Association (1991-92). NCAA Injury Surveillance System for 1991-1992. Overland, KS: Authors.

Nideffer, R. M. (1976a). Test of Attentional and Interpersonal Style. Journal of Personality and Social Psychology, 34, 394-404.

Nideffer, R. M. (1976b). An interpreter's manual for the Test of Attentional and Interpersonal Style. Rochester, NY: Behavioral Research Applications Group.

Nideffer, R. M. (1983). The ethics and practice of applied sport psychology. New York: Movement Publications.

Passer, M. W. (1982). Children in sport: Participation motives and psychological stress. Quest, 33, 231-244.

Passer, M. W., & Seese, M. D. (1983). Life stress and athletic injury: Examination of positive versus negative events and three moderator variables. Journal of Human Stress, 9, 11-16.

Pelmear, P. L. (1985). Noise and health. In W. Tempest (Ed.), The noise handbook. New York: Academic Press.

Petrie, T. A. (1992). Psychosocial antecedents of athletic injury: The effects of life stress and social support on female collegiate gymnasts. Behavioural Medicine, 18, 127-138.

Petrie, T. A. (1993a). The moderating effects of social support and playing status on the life stress-injury relationship. Journal of Applied Sport Psychology, 5, 1-16.

Petrie, T. A. (1993b). Coping skills, competitive trait anxiety, and playing status: Moderating effects on the life stress-injury relationship. Journal of Sport and Exercise Psychology, 15, 261-274.

Petrie, T. A. (1997). Methodological and statistical issues in sport injury prediction research. . In R. Lidor & M. Bar-Eli (Eds.), Innovations in sport psychology: Linking theory and practice, Proceedings of the IX World Congress of Sport Psychology (pp. 555-557). Netanya, Israel: Wingate Institute.

Prapavessis, H., Grove, J. R., McNaire, P. J., & Cable, N. T. (1992). Self-regulation training, state anxiety and sport performance: A psychophysiological case study. The Sport Psychologist, 6, 213-229.

Roseman, R. M., & Friedman, M. (1974). Type A behaviour and your heart. New York: Knopt.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 80, 1-28.

Russel, P. K., & Sipich, J. F. (1973). Cue-controlled relaxation in the treatment of test anxiety. Journal of Behaviour Therapy and Experimental Psychiatry, 4, 47-49.

Sanderson, F. H. (1977). The psychological implications of injury. British Journal of Sports Medicine, 12, 41-43.

Sarason, I. G., Johnson, J. H., & Siegel, J. M. (1978). Assessing the impact of life changes: Development of the Life Experiences Survey. Journal of Consulting and Clinical Psychology, 46, 932-946.

Sarason, I. G., Levine, H. M., Basham, R. B., & Sarason, B. R. (1983). Assessing social support: The Social Support Questionnaire. Journal of Personality and Social Psychology, 44, 127-139.

Sarason, I. G., Sarason, B. R., Shearin, E. N., & Pierce, G. R. (1987). A brief measure of Social Support: Practical and theoretical implications. Journal of Social and Personal Relationships, 4, 497-510.

Schmidt, R. A. (1982). Motor control and learning: A behavioral emphasis. Champaign, IL: Human Kinetics.

Schultz, J. (1953). Das autogene training. Stuttgart: Geerg-Thieme Verlag.

Schultz, J., & Luthe, W. (1959). Autogenic training: A psychophysiological approach to psychotherapy. New York: Grune and Stratton.

Selye, H. (1974). Stress without distress. New York: New American Library.

Selye, H. (1976). The stress of life. New York: McGraw-Hill.

Seward, H., & Patrick, J. (1992). A three year survey of Victorian football league injuries. The Australian Journal of Science and Medicine in Sport, 24, 51-54.

Smith, A. D. (1996). Psychological impact of injuries in athletes. Sports Medicine, 22, 391-405.

Smith, R. E. (1980). A cognitive-affective approach to stress management training for athletes. In C. H. Nadeau, W. R. Halliwell, K. M. Newell, & G. C. Roberts (Eds.), Psychology of motor behaviour and sport (pp. 54-72). Champaign, IL: Human Kinetics.

Smith, R. E. (1985). A component analysis of athletic stress. Sport psychology for children and youth: Proceedings of the 1984 Olympic Scientific Congress, Vol. 10 (pp. 107-111). Champaign, IL: Human Kinetics.

Smith, R. E., & Ascough, J. C. (1985). Induced affect in stress management training. In S. R. Burchfield (Ed.), Stress: Psychological and physiological interactions. New York: Hemisphere.

Smith, R. E., Ptacek, J. T., & Smoll, F. L. (1992). Sensation seeking, stress, and adolescent injuries: A test of stress-buffering, risk-taking, and coping skills hypotheses. Journal of Personality and Social Psychology, 62, 1016-1024.

Smith, R. E., Schutz, R. W., Smoll, F. L., & Ptacek, J. T. (1995). Development and validation of a multidimensional measure of sport-specific psychological skills: The Athletic Coping Skills Inventory-28. Journal of Sport and Exercise Psychology, 17, 379-398.

Smith, R. E., Smoll, F. L., & Ptacek, J. T. (1990). Conjunctive moderator variables in vulnerability and resiliency research: Life stress, social support, and coping skills and adolescent sport injuries. Journal of Personality and Social Psychology, 58, 360-370.

Smith, R. E., Smoll, F. L., & Schutz, R. (1988). The Athletic Coping Skills Inventory: Psychometric properties, correlates and confirmatory factor analysis. Unpublished manuscript, University of Washington.

Spence, J. J., & Spence, K. W. (1966). The motivational components of manifest anxiety: Drive and drive stimuli. In C.D. Spielberger (Ed). Anxiety and Behaviour, 291-323.

Spielberger, C. D. (1966). Anxiety and behaviour. New York: Academic Press

Spielberger, C. D. (1972). Anxiety as an emotional state. In C. D. Spielberger (Ed.), Anxiety: Current trends in theory and research (Vol. 1, pp. 23-49). New York: Academic Press.

Spielberger, C. D. (1975). Anxiety: State-trait process. In C. D. Spielberger & I. G. Sarason (Eds.), Stress and anxiety (Vol. 1, pp. 115-143). Washington: Hemisphere.

Spielberger, C. D. (1989). Stress and anxiety in sports. In D. Hackfort & C. D. Spielberger (Eds.), Anxiety in sport. New York: Hemisphere Publishing.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. L.(1970). Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists.

Suinn, R. M. (1982). Imagery and sports. In A. Sheikh (Ed.), Imagery, current theory, research and application (pp. 507-534). New York: Wiley & Sons.

Suinn, R. M. (1993). Imagery. In R. N. Singer, M. Murphy & L. K. Tennant (Eds.), Handbook of research on sport psychology (pp. 492-510). Don Mills, Ontario: Macmillan.

Suinn, R. M., & Richardson, F. (1971). Anxiety management training: A non specific behaviour therapy program for anxiety control. Behaviour Therapy, 2, 498-510.

Summers, J., Fawkner, H., & McMurray, N. (1993). Predisposition to athletic injury: The role of psychosocial factors. The 8th World Congress of Sport Psychology; Abstract (p. 94). Lisbon: ISSP Publisher.

Suvongvan, T. (1984). Age and sex differences in response to stress during fine motor performance. Unpublished master's thesis, University of Illinois, Chicago.

Thompson, N. J., & Morris, R. D. (1994). Predicting injury risk in adolescent football players: The importance of psychological variables. Journal of Pediatric Psychology, 19, 415-429.

Tunks, T., & Bellissimo, A. (1988). Coping with the coping concept: A brief comment. Pain, 34, 171-174.

Valliant, P. M. (1981). Personality and injury in competitive runners. Perceptual and Motor Skills, 53, 251-253.

Van Schoyck, S. R., & Grasha, A. F. (1981). Attentional style variations and athletic ability: The advantage of a sports-specific test. Journal of Sport Psychology, 3, 149-165.

Verbrugge, L. M. (1985). Triggers of symptoms and health care. Social Science in Medicine, 20, 855-876.

Weinberg, R. S., & Comar, W. (1994). The effectiveness of psychological intervention in competitive sport. Sport Medicine, 18, 406-418.

Weiss, M. R., & Troxell, R. K. (1986). Psychology of the injured athlete. Athletic Training, 2, 104-109.

Wiese, D. M., & Weiss, M. R. (1987). Psychological rehabilitation and physical injury: Implications for the sports medicine team. The Sport Psychologist, 1, 318-330.

Wilding, J., & Mohindra, N. (1980). Effects of subvocal suppression, articulating aloud, and noise on sequence recall. British Journal of Psychology, 71, 247-262.

Williams, J. M., & Andersen, M. B. (1997). Psychosocial influences on central and peripheral vision and reaction time during demanding tasks. Behavioral Medicine, 26, 160-167.

Williams, J. M., & Andersen, M. B. (In press). Psychosocial antecedents of sport injury: Review and critique of the stress and injury model. Journal of Applied Sport Psychology.

Williams, J. M., Haggert, J., Tonymon, P., & Wadsworth, W. A. (1986). Life stress and prediction of athletic injuries in volleyball, basketball, and cross-country running. In L. E. Unestahl (Ed.), Sport psychology in theory and practice. Orebro, Sweden: Veje.

Williams, J. M., Hogan, T. D., & Andersen, M. B. (1993). Positive states of mind and athletic injury risk. Psychosomatic Medicine, 55, 468-472.

Williams, J. M., & Roepke, N. (1993). Psychology of injury and injury rehabilitation. In R. N. Singer (Ed.), Handbook of research in sport psychology (pp. 815-839). New York: Macmillan.

Williams, J. M., Tonymon, P., & Andersen, M. B. (1990). Effects of life-event stress on anxiety and peripheral narrowing. Behavioral Medicine, 16, 174-181.

Williams, J. M., Tonymon, P., & Andersen, M. B. (1991). The effects of stressors and coping resources on anxiety and peripheral narrowing. Journal of Applied Sport Psychology, 3, 126-141.

Williams, J. M., Tonymon, P., & Wadsworth, W. A. (1986). Relationship of stress to injury in intercollegiate volleyball. Journal of Human Stress, 12, 38-43.

Wittig, A. F., & Schurr, K. T. (1994). Psychological characteristics of women volleyball players: Relationships with injuries, rehabilitation, and team success. Personality and Social Psychology Bulletin, 20, 322-330.

Young, M. L., & Cohen, D. A. (1979). Self-concept and injuries among female high school basketball players. Journal of Sports Medicine, 21, 55-59.

Young, M. L., & Cohen, D. A. (1981). Self-concept and injuries among female college tournament basketball players. American Corrective Therapy Journal, 33, 139-142.

Zaichkowsky, L., & Takenaka, K. (1993). Optimising arousal level. In R. N. Singer, M. Murphy, & L. K. Tennant (Eds.), Handbook of research on sport psychology (pp. 328-364). Don Mills, Ontario: Macmillan.

Zuckerman, M. (1979). Sensation seeking: Beyond the optimal level of arousal. Hillsdale, NJ: Erlbaum.

Appendices

Appendix A

Consent Form (Study 1)

Nature of the Study

This is a research project about the relationship of life stress and to athletic injury. To participate in this research, you will be required to complete questionnaires. The responses you give to the questionnaires must be as honest as possible. This research will help to decrease future injury to highly stressed athletes, especially in contact sports, through early recognition and management of the high stress levels. Results from the questionnaires and any other materials will be kept totally confidential. You are free to withdraw from the research at any time. You are also encouraged to ask questions at any time if you have any queries.

Informed Consent

I acknowledge that the experimental interventions have been explained to me.

I acknowledge that I have been given the chance to ask questions.

I acknowledge that I may ask further questions at any time.

I have been informed that I am free to withdraw at any time.

I have been informed that my results will be confidential.

Signed-- Date--------------------------

Appendix B

Consent Form (Study 2)

Nature of the Study

This is a research project about the effects of physical exercise and noise on performance. In this research, you will be required to complete a number of questionnaires which ask how different aspects of your life affect you. Then you will ride a bicycle to test your fitness. On a later date which suits you, you will then ride the bicycle for a period of several minutes at a level of moderate physical effort while performing a task where you press a button each time light comes on. You will wear headphones but no noise will come through them. After a break, you will ride the bicycle for a period of several minutes at the same level of effort and this time a hissing noise will come through the headphones. Your involvement will be for about 30 minutes on each occasion. Results from the experiment and any other materials will be kept totally confidential. You are free to withdraw from the experiment at any time. You are also encouraged to ask questions at any time if you have any queries.

Informed Consent

I acknowledge that :

The nature of the study has been explained to me.

I have been given the chance to ask questions.

I may ask further questions at any time.

I have been informed that I may withdraw at any time.

I have been informed that my results will be confidential.

Signed--- Date--------------------------

Appendix C

Consent Form (Study 3)

Nature of the Study

This is a research project about the effects of stress and life stress on visual attention, which examines the effects of a stress management program. In this research, you will be required to complete a number of questionnaires which ask how different aspects of your life affect you. Then you will ride a stationary bicycle in a laboratory to test your fitness. On a later date which suits you, you will then ride the bicycle for a period of several minutes at a level of moderate physical effort while performing a task where you press different buttons each time different lights come on. You will wear headphones and sometimes hissing noise will come through them, but at other times no noise will come through them. After this, you will take part in a eight weeks stress management program (treatment group only). After eight weeks, you will do the same exercise of pressing buttons when lights come on in the same bicycle riding and noise conditions. Results from the experiment and any other materials will be kept totally confidential. You are free to withdraw from the experiment at any time. You are also encouraged to ask questions at any time if you have any queries.

Informed Consent

I acknowledge that :

The nature of the study has been explained to me.

I have been given the chance to ask questions.

I may ask further questions at any time.

I have been informed that I may withdraw at any time.

I have been informed that my results will be confidential.

Signed-- Date------------------

Appendix D

Injury Surveillance System

1. Sport:
   (1) Football - men's
   (2) Hockey - men's and women's
   (3) Judo - men's and women's
   (4) Taekwando - men's and women's
   (5) Lacrosse - men's and women's

2. Name: ____________________ 3. Age: ______________years

4. Height: _____________inches 5. Weight: _____________kg

6. Date of injury: ___________________
   (month/day)

7. Injury occurred in:
   (1) Competition - varsity (2) Competition - subvarsity
   (3) Practice (4) Weight room

8. This injury is a:
   (1) New injury
   (2) Recurrence of injury from this season
   (3) Recurrence of injury from pervious season (this sport)
   (4) Complication of previous injury (this sport)
   (5) Recurrence of other sport injury
   (6) Recurrence of nonsport injury
   (7) Complication of previous other sport injury

9. Has athlete had unrelated injury recorded this season?
   (1) Yes (2) No

10. How long did this injury keep the athlete from participating in the sport?
   (1) 1-2 days (2) 3-6 days (3) 7-9 days
   (4) 10 days or more (5) Catastrophic, nonfatal (6) Fatal

11. Weather:
   (1) No precipitation (2) Rain (3) Snow (4) Indoor

12. This injury involved:
   (1) Contact with another competitor (2) Contact with playing surface
   (3) Contact with apparatus/ball (4) Contact with other in environment (e.g., wall, fence, spectators)
   (5) No apparent contact (rotation about planted foot)
   (6) No apparent contact (pulled muscle) (7) Other:_____________________________________

13. Principal body part injured:
   (1) Head (2) Eye(s) (3) Ear(s) (4) Nose (5) Face
   (6) Chin (7) Jaw (8) Mouth (9) Teeth (10) Tongue
   (11) Neck (12) Shoulder (13) Clavicle (14) Scapula (15) Upper arm

(16) Elbow (17) Forearm (18) Wrist (19) Hand (20) Thumb
(21) Finger(s) (22) Upper Back (23) Spine (24) Lower Back (25) Ribs
(26) Sternum (27) Stomach (28) Pelvis, Hips (29) Buttocks (30) Upper leg
(31) Knee (32) Patella (33) Lower leg (34) Ankle (35) Heel/Achilles Tendon
(36) Foot (37) Toe(s) (38) Spleen (39) Kidney (40) External genitalia
(41) Coccyx (42) Other: ______________________________

14. Primary type of injury:
(1) Abrasion (2) Contusion (3) Laceration (4) Puncture wound
(5) Bursitis (6) Tendinitis (7) Sprain (ligament) (8) Ruptured ligament(s)
(9) Strain (muscle) (10) Ruptured tendon (11) Torn cartilage (12) Hyperextension
(13) Separation (14) Subluxation (15) Dislocation (16) Fracture
(17) Stress fracture (18) Concussion (19) Heat exhaustion (answer Heat injury information)
(20) Heat stroke (answer Heat injury information) (21) Burn
(22) Inflammation (23) Infection (24) Hemorrhage (25) Internal injury
(26) Nerve injury (27) Blisters (28) Boil(s) (29) Hernia
(30) Foreign object in body orifice (31) Overuse
(32) Other: ______________________

15. Did this injury require surgery?
(1) Yes (2) Scheduled for postseason surgery (3) No

16. Where did this injury occur?
(1) Home (2) Away (3) Other: __________

17. Injury occurred during:
(1) Preseason (before first regular-season contest) (2) Regular season
(3) Postseason (after final regular-season contest) (4) Other: ______________

18. Injury was caused by:
(1) Injured player coming down on another player
(2) Another player coming down on injured player
(3) Other contact with another player
(4) Contact with rim or backboard
(5) Contact with standard
(6) Contact with floor
(7) Contact with ball
(8) Contact with out-of-bounds observers (team, fans, media, cheerleaders)
(9) Contact with out-of-bounds apparatus (tables, bleachers, cameras)
(10) No apparent contact
(11) Other: ______________________________

Appendix E

Athletic Life Experience Survey

INSTRUCTIONS:

Listed below are a number of events which sometimes bring about a change in the lives of those who experience them. Please circle the number next to those events which you have experienced in the past year. After you have circled all events that have happened in the past year go back and indicate your answer to the following questions by circling the number below.

1). When did it happen?
   a. Last 4 months
   or
   b. Between 4 months and a year ago

2). At the time it happened was it a good or bad event for you?

3). At the time it happened how much of an effect did it have on your life?

Please answer all the questions honestly. Some of the questions may seem very personal but remember that all answers are will remain strictly confidential.

EVENT	0 to 3 month	4 to 1yr	TYPE OF EVENT		EFFECT OF EVENT			
			GOOD	BAD	NONE	SOME	MOD	GREAT
1. Marriage.	1	2	1	2	1	2	3	4
2. Trouble with head coach.	1	2	1	2	1	2	3	4
3. Trouble with athletic director or general manager.	1	2	1	2	1	2	3	4
4. Major change in sleeping habits (much more or much less).	1	2	1	2	1	2	3	4
5. Death of a close family member.	1	2	1	2	1	2	3	4
6. Major change in eating habits (much more or much less).	1	2	1	2	1	2	3	4
7. Payments not made on a lone.	1	2	1	2	1	2	3	4
8. Death of a close friend.	1	2	1	2	1	2	3	4
9. Loss of a close friend through other than death (argument, moving etc.).	1	2	1	2	1	2	3	4
10. Outstanding personal achievement.	1	2	1	2	1	2	3	4
11. Minor law violation (traffic tickets disturbing the peace etc.)	1	2	1	2	1	2	3	4

EVENT	0 to 3 moth	4 to 1 yr	TYPE OF EVENT GOOD	BAD	EFFECT OF EVENT NONE	SOME	MOD	GREAT
12. Male: Wife/girlfriend's pregnancy.	1	2	1	2	1	2	3	4
13. Trouble with assistant coaches.	1	2	1	2	1	2	3	4
14. Changed work allocation (different work responsibilities, major change in working conditions , working hours).	1	2	1	2	1	2	3	4
15. New job.	1	2	1	2	1	2	3	4
16.Serious physical illness or injury of close family member.	1	2	1	2	1	2	3	4
17. Sexual difficulties.	1	2	1	2	1	2	3	4
18. Trouble with employer (being suspended, fired, demoted, etc).	1	2	1	2	1	2	3	4
19. Trouble with girlfriend's parents or in-law.	1	2	1	2	1	2	3	4
20. Major change in financial status (a lot better off or a lot worse off).	1	2	1	2	1	2	3	4
21. Major change in parents financial status.	1	2	1	2	1	2	3	4
22. Major change in closeness of family members (increase or decrease in closeness).	1	2	1	2	1	2	3	4
23. Gaining a new family member (through birth, adoption, family member moving in) etc.	1	2	1	2	1	2	3	4
24. Separation from girlfriend or wife (due to conflict).	1	2	1	2	1	2	3	4
25. Move to a new house or apartment within the same city or town.	1	2	1	2	1	2	3	4
26. Move to a new city or town.	1	2	1	2	1	2	3	4
27. Major change in church activities (increased or decreased attendance).	1	2	1	2	1	2	3	4

EVENT	0 to 3 moth	4 to 1 yr	TYPE OF EVENT GOOD	BAD	EFFECT OF EVENT NONE	SOME	MOD	GREAT
28. Major change in number of arguments with girlfriend or wife (a lot more or a lot less).	1	2	1	2	1	2	3	4
29. Major change in playing hours or conditions.	1	2	1	2	1	2	3	4
30. Major increases in responsibilities on team; captain, vice captain etc.	1	2	1	2	1	2	3	4
31. Major change in usual recreation.	1	2	1	2	1	2	3	4
32. Change to a new position (i.e., on the team).	1	2	1	2	1	2	3	4
33 Borrowing less than $10.000 (buying a car, TV, getting a loan etc.).	1	2	1	2	1	2	3	4
34. Being dropped to a lesser playing status e.g.: league to reserve.	1	2	1	2	1	2	3	4
35. Parents, girlfriend or spouse losing their job.	1	2	1	2	1	2	3	4
36. Male: wife/girlfriend having an abortion.	1	2	1	2	1	2	3	4
37. Being moved to a higher playing status e.g.: reserves to league.	1	2	1	2	1	2	3	4
38. Major personal illness or injury.	1	2	1	2	1	2	3	4
39. Major change in social activities e.g.: parties, movies, visiting.	1	2	1	2	1	2	3	4
40. Serious emotional problem of a family number.	1	2	1	2	1	2	3	4
41. Serious emotional problem of a close friend.	1	2	1	2	1	2	3	4
42. Major change in living conditions of family (building new home, remodeling, decoration of home, neighborhood).	1	2	1	2	1	2	3	4
43. Playing time lost due to injury or illness.	1	2	1	2	1	2	3	4
44. Parents divorced or separated.	1	2	1	2	1	2	3	4

EVENT	0 to 3 moth	4 to 1 yr	TYPE OF EVENT GOOD	BAD	EFFECT OF EVENT NONE	SOME	MOD	GREAT
45. Serious injury or physical illness of a close friend.	1	2	1	2	1	2	3	4
46. Difficulties with trainer or team physician.	1	2	1	2	1	2	3	4
47. Brother or sister leaving home (due to marriage, college etc.).	1	2	1	2	1	2	3	4
48. Discrimination from coaches or team members.	1	2	1	2	1	2	3	4
49. Temporary separation from girlfriend/spouse due to work, school etc.	1	2	1	2	1	2	3	4
50. Major decrease in responsibility on team; e.g. finished captaincy, or vice-captaincy etc.	1	2	1	2	1	2	3	4
51. Engagement	1	2	1	2	1	2	3	4
52. Breaking up with girlfriend/wife.	1	2	1	2	1	2	3	4
53. Leaving home for the first time.	1	2	1	2	1	2	3	4
54. Reconciliation with girlfriend/wife girlfriend or wife.	1	2	1	2	1	2	3	4
55. Beginning a new schooling experience at a higher level (college, graduate, professional school).	1	2	1	2	1	2	3	4
56. Changing to a new school or team at the same level.	1	2	1	2	1	2	3	4
57. Academic probation.	1	2	1	2	1	2	3	4
58.-Failing an important exam.	1	2	1	2	1	2	3	4
59. Difficulties with eligibility-scholastic, transfer, credits etc.	1	2	1	2	1	2	3	4
60. Changing a major (school subject).	1	2	1	2	1	2	3	4
61. Failing a course.	1	2	1	2	1	2	3	4
62. Dropping a course.	1	2	1	2	1	2	3	4
63. Joining a fraternity/ service club (e.g. Rotary, Lions etc.).	1	2	1	2	1	2	3	4
64. Financial problems concerning school (in danger of not having sufficient money to continue).	1	2	1	2	1	2	3	4

EVENT	0 to 3 moth	4 to 1 yr	TYPE OF EVENT GOOD	BAD	EFFECT OF EVENT NONE	SOME	MOD	GREAT
65. Discrimination in community, at home, or away.	1	2	1	2	1	2	3	4
66. Major errors in practice or games.	1	2	1	2	1	2	3	4
67. Difficulties in demonstrating athletic ability.	1	2	1	2	1	2	3	4
68. Conflict with teammate/s.	1	2	1	2	1	2	3	4
69. Reprimanded severely by coach during practice or game.	1	2	1	2	1	2	3	4
70. Outstanding performance acknowledged by coach, TV or newspaper.	1	2	1	2	1	2	3	4

Appendix F

Athletic Coping Skills Inventory

Name :

DIRECTIONS: A number of statements that athletes have used to describe their experiences are given below. Please read each statement carefully and then recall as accurately as possible how often you experience the same thing. There are no right or wrong answers. Do not spend too much time on any one statement.

1 - Almost never	2 - Sometimes
3 - Often	4 - Almost Always

1. I play relaxed even under intense pressure ( ).
2. I find myself thinking of past mistakes and missed opportunities as I perform ( ).
3. On a daily or weekly basis, I set very specific goals for myself that guide what I do ( ).
4. I remain positive and enthusiastic during competition, no matter how badly things are going ( ).
5. I get the most out of my talent and skills ( ).
6. When a coach or manager tells me how to correct a mistake I've made, I tend to take it personally and feel upset ( ).
7. I can focus my attention narrowly and block out distractions ( ).
8. I can quickly bounce back from a tough loss or a major mistake on my part ( ).
9. I tend to "peak" under pressure because I think more clearly ( ).
10. I worry quite a bit about what others think about my performance ( ).
11. I tend to do lots of planning about how to reach my goals ( ).
12. When I am feeling down in the dumps I try to think about pleasant things ( ).
13. I feel confident that I will play well ( ).
14. When a coach or manager criticizes me, I become upset rather than helped ( ).
15. It is easy for me to keep distracting thoughts from interfering with something I am watching or listening to( ).
16. When I make a mistake or get a bad break, I can forget about it quickly so it doesn't affect my play ( ).
17. I feel confident that I won't choke under pressure ( ).
18. I put a lot of pressure on myself by worrying about how I will perform ( ).
19. I set my own performance goals for each practice ( ).
20. When I feel depressed, I try to keep myself busy doing thing I like ( ).
21. I don't have to be pushed to practice or play hard; I give 100% ( ).
22. If a coach criticizes or yells t me, I correct the mistake without getting upset about it ( ).
23. I handle unexpected situations in my sport very well ( ).
24. When things are going badly, I tell myself to keep calm, and this works for me ( ).
25. The more pressure there is during a game, the more I enjoy it ( ).
26. While competing, I worry about making mistakes or failing to come through ( ).
27. I have my own game plan worked out in my head long before the game begins ( ).
28. If I'm feeling "flat", I can get myself "psyched up" enough to perform at my best ( ).
29. When something upsets me, I can't put it out of my mind, and my performance suffers as a result ( ).
30. When I feel myself getting too tense, I can quickly relax my body and calm myself ( ).
31. To me, pressure situations are challenges that I welcome ( ).
32. I think about and I imagine what will happen if I fail or screw up ( ).
33. I take time before a game to mentally prepare myself ( ).
34. I maintain an "even keel" regardless of how things are going for me ( ).
35. It is easy for me to direct my attention and focus on a single objects or person ( ).
36. I get nervous and worry a lot before games or matches ( ).
37. I mentally practice working through tough situations prior to competition ( ).
38. When I fall to reach my goals, it makes me try even harder ( ).
39. I improve my skills by listening carefully to advice and instruction from coaches and managers ( ).
40. I make fewer mistakes when the pressure is on because I concentrate better ( ).
41. My performance level is about the same from day to day ( ).
42. My emotions keep me from performing at my best ( ).

Appendix G

Social Support Questionnaire (SSQ-6)

Name:

INSTRUCTIONS: The following questionnaire asks about people in your environment who provide you with support or help. Each question has two parts, firstly list all the people who you can count on in the described manner. Just give their initials and their relationship to you e.g.: brother, sister, boyfriend etc. Secondly circle how satisfied you are with the level of support. If you have had no support for a question tick "no one", but still rate your level of satisfaction.

Please answer all the questions as best you can. All responses will remain confidential

1. Whom can you count on to distract you from your worries when you fell under stress?

( ) No one	1)	4)	7)
	2)	5)	8)
	3)	6)	9)

1-1. How satisfied are you with this support?

6. very satisfied	5. fairly satisfied	4. a little satisfied
3. little dissatisfied	2. fairly dissatisfied	1. very dissatisfied

2. Whom can you really count on to help you feel more relaxed when you are under pressure or tense?

( ) No one	1)	4)	7)
	2)	5)	8)
	3)	6)	9)

2-1. How satisfied are you with this support?

6. very satisfied	5. fairly satisfied	4. a little satisfied
3. little dissatisfied	2. fairly dissatisfied	1. very dissatisfied

3. Who accepts you totally, including both your worst and best points?

( ) No one	1)	4)	7)
	2)	5)	8)
	3)	6)	9)

3-1. How satisfied are you with this support?

6. very satisfied	5. fairly satisfied	4. a little satisfied
3. little dissatisfied	2. fairly dissatisfied	1. very dissatisfied

4. Whom can you really count on to care about you, regardless of what is happening to you?

( ) No one	1)	4)	7)
	2)	5)	8)
	3)	6)	9)

4-1. How satisfied are you with this support?

6. very satisfied	5. fairly satisfied	4. a little satisfied
3. little dissatisfied	2. fairly dissatisfied	1. very dissatisfied

5. Whom can you count on to help you feel better when you are feeling generally down-in-the-dumps?

( ) No one	1)	4)	7)
	2)	5)	8)
	3)	6)	9)

5-1 . How satisfied are you with this support?

6. very satisfied	5. fairly satisfied	4. a little satisfied
3. little dissatisfied	2. fairly dissatisfied	1. very dissatisfied

6. Whom can you count on to console you when you are very upset?

( ) No one	1)	4)	7)
	2)	5)	8)
	3)	6)	9)

6-1. How satisfied are you with this support?

6 very satisfied	5 fairly satisfied	4 a little satisfied
3 little dissatisfied	2 fairly dissatisfied	1 very dissatisfied

Appendix H

State-Trait Anxiety Inventory

Name :

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then mark the appropriate response to the right of the statement to indicate how you feel right now, that is, at this very moment.

There are no right or wrong answers. Don't spend too much time on any one statement but give the answer that seems to desirable your present feelings best.

EVENT	not at all	somewhat	moderately so	very much so
I feel calm	1	2	3	4
I feel secure	1	2	3	4
I am tense	1	2	3	4
I am regretful	1	2	3	4
I feel at ease	1	2	3	4
I feel upset	1	2	3	4
I am presently worrying over possible misfortunes	1	2	3	4
I feel rested	1	2	3	4
I feel anxious	1	2	3	4
I feel comfortable	1	2	3	4
I feel self-confident	1	2	3	4
I feel nervous	1	2	3	4
I am jittery	1	2	3	4
I feel "high strung"	1	2	3	4
I am relaxed	1	2	3	4
I feel content	1	2	3	4
I am worried	1	2	3	4
I feel over-excited and rattled	1	2	3	4
I feel joyful	1	2	3	4
I feel pleasant	1	2	3	4

Appendix I

Goldman ring peripheral vision task program

Data file begins beyond the character ~
Fist entry in data file corresponds to the number of trials
Second entry corresponds to the time-out period in milliseconds
Third entry corresponds to the warning delay period
Fourth entry signifies whether the warning is to be used at start & finish of each trial series
i.e. 1=signifying start & finish, else 0
Trial data follows from this point onward

#	L.E.D.#	Delay (ms)
~		
120		
5000		
0		
1	104	300
2	104	400
3	104	300
4	152	500
5	104	300
6	177	400
7	52	350
8	104	300
9	168	400
10	104	500
11	104	400
12	63	400
13	104	300
14	162	300
15	104	400
16	104	400
17	31	450
18	104	300
19	104	400
20	36	500
21	104	300
22	137	300
23	104	400
24	142	600
25	104	400
26	172	300
27	104	400
28	104	350
29	69	450
30	104	400
31	104	400
32	42	650
33	104	450
34	104	500
35	104	400
36	63	400
37	104	600
38	37	550
39	104	400
40	104	620
41	52	500
42	104	300
43	104	300
44	104	500
45	157	600
46	104	400
47	28	550
48	104	400
49	104	500
50	104	500
51	152	300
52	104	500
53	180	400
54	104	400
55	137	400
56	69	500
57	104	600
58	104	400
59	147	500
60	104	300
61	58	600
62	104	300
63	104	550
64	167	300
65	148	600
66	104	300
67	104	600
68	157	300
69	42	400
70	104	300
71	168	600
72	104	500
73	37	400
74	104	400
75	142	400
76	104	500
77	28	300
78	104	500
79	104	500
80	58	400
81	104	300
82	104	500
83	68	400
84	104	600
85	148	500
86	104	400
87	104	500
88	53	500
89	104	300
90	104	400
91	104	500
92	162	600
93	104	500
94	104	400
95	180	600
96	104	500
97	104	400
98	147	500
99	36	400
100	104	350
101	104	350
102	177	400
103	104	350
104	104	300
105	53	400
106	104	350
107	68	500
108	104	400
109	104	300
110	104	350
111	47	400
112	167	500
113	104	350
114	104	400
115	172	500
116	104	300
117	47	400
118	104	500
119	31	350
120	104	300

Appendix J

Autogenic Training Script

O.K. Get yourself a nice comfortable position, settle back… take a couple of nice deep breaths… take in….and out, take another nice deep breath in… and out, and feel yourself beginning to relax. Feel yourself letting go as you now focus very keenly on your right arm and say it to yourself over and over inside your head.

My right arm is heavy (repeat two times)… and feel the heaviness spread throughout your right arm into your shoulder. My right arm is heavy (repeat)… Get your-self an nice comfortable position settle back…take couple of nice deep breaths…take in…and out, take another nice deep breaths in…and out, and feel your-self beginning of relax. Feel your-self letting go as you know focus very keenly on your right arm and say it your-self over and over inside your head.

feel your right arm comfortably sinking. My right arm is heavy (repeat)… and that heaviness will continued to grow as you now move your tension from your right arm to your left arm.

Say your-self… my left arm is heavy (repeat two times)… and feel the heaviness spread through out your left arm and into your shoulder. My left arm is heavy (repeat)… and feel your left arm comfortably sinking..my left arm is heavy (repeat two times)… and feel that heaviness spread through out your arms and into your shoulders. Both my arms are heavy (repeat)… and feel your arms comfortably sinking.. Both my arms are heavy (repeat)… that heaviness will continued to grow as you now move your tension from your arm to your right leg..

Say to your-self...my right leg is heavy (repeat two times)… and feel that heaviness spread from your right leg and into your hip. My right leg is heavy (repeat)… and feel your right leg comfortably sinking. My right leg is heavy (repeat)… and that heaviness will continue to grow as you now move your attention from your right leg to your left leg..

Say to your-self, my left leg is heavy (repeat two times)… and feel the heaviness spread from you left leg and into your hip. My left leg is heavy (repeat)… feel your left leg comfortably sinking. My left leg is heavy (repeat)… say to your-self both my legs are heavy (repeat two times)… and feel that heaviness spread through out your legs and into your hips. Both my legs are heavy (repeat)… and feel your legs comfortably sinking. Both my legs are heavy (repeat)… say to your-self... my arms and legs are heavy (repeat two times)… and feel that heaviness spread through out your arms and shoulders, legs and hips.. my arms and legs are heavy (repeat)… and feel your arms and legs comfortably sinking.. my arms and legs are heavy (repeat)…

And that heaviness will continue to grow as now move your tension once again to right arm. say to your-self over and over, my right arm is warm (repeat two times)… and feel warm spread through out your right arm into your shoulders.... my right arm is warm (repeat)… and feel the fresh warm blood flowing your right arm. my right arm is warm (repeat)... and the warm continued to grow as now move your tension from your right arm to left arm say to your-self ..my left arm is warm (repeat),... and feel warm spread through out your left arm into your shoulders...my left arm is warm (repeat)… and feel the fresh warm blood flowing your left arm...my left arm is warm (repeat)… say to your-self...both my arms are warm (repeat two times).. and feel warm spread through out your arms into your shoulders ...both my arms are warm (repeat)… and feel the fresh warm flowing your arms...both my arms are warm (repeat)… and that warm will continue to grow as now move your tension from your arms down again to your right leg.

Say to your-self...my right leg is warm (repeat two times)... and feel warm spread from your right leg into your hips...my right leg is warm (repeat)… and feel the fresh warm blood flowing in your right leg... my right leg is warm (repeat)… and that warm continued to grow as you now move your tension from your right leg to your left leg.

Say to your-self...my left leg is warm (repeat two times)... and feel warm spread through out your left leg into your hips... my left leg is warm (repeat)… an feel the fresh warm blood flowing in your left leg ...my left leg is warm (repeat)… and say to your-self...both my legs are warm (repeat two times)... and feel warm spread through out your legs into hips.. both my legs are warm (repeat)… and feel the fresh warm blood flowing in your legs.. both my legs are warm (repeat)… and say to your-self...my arms and legs are warm (repeat two times)... and feel warm spread through out your arms and shoulders, legs and hips.. my arms and legs are warm (repeat)… and feel the fresh warm blood flowing in your arms and legs....my arms and legs are warm (repeat).

And say to your-self...my arms and legs are warm and heavy (repeat two times).. and that heaviness spread .. my arms and legs are warm and heavy (repeat)… and feel the warm and heaviness grow... my arms, legs are warm and heavy (repeat)… and that warm and heaviness will continue to spread as now move your tension to your heart.. feel your heart beat….. maybe you feel it in your chest, down your legs as you say to yourself…my heartbeat is calm and regular (repeat), and feel your strong heart beat… and that strong steady beat will continue as you now just notice your breathing. feel your chest rising up and falling down on its own accord…. Easy effortless breathing as you say to yourself….. it breathes me (repeat)…chest rising and falling like you have nothing to do with it…. It breathes me (repeat)….like the air is pushed into you and pulled out of you, you are passive it breathes me (repeat)..easy effortless breathing as if you have nothing to do with it. It breathes me (repeat)….and the effortless breathing will continue as you focus on your solar plexus and say… my solar plexus is warm (repeat), and feel the warmth radiating in all directions just like a sunburst… my solar plexus is warm (repeat), and feel the warmth radiating out.. my solar plexus is warm (repeat), feel the warmth growing…. And now move your tension from your solar plexus as the warmth continues to grow to your forehead and say to yourself… my forehead is cool (repeat)… and feel it like a nice cool breeze… my forehead is cool (repeat)…cool breeze… my forehead is cool (repeat)… and now that you have relaxed go ahead now and put pictures inside your head of what you wanted to see today, what you wanted to do, how you wanted to feel… run the pictures that you have planned today and enjoy yourself.

The number of times/week	Date	Start time	End time	Comments
32/5				
33/5				
34/5				
35/5				
36/6				
37/6				
38/6				
39/6				
40/6				
41/6				
42/6				
43/7				
44/7				
45/7				
46/7				
47/7				
48/7				
49/7				
50/8				
51/8				
52/8				
53/8				
54/8				
55/8				
56/8				