EFFICIENCY OF COPING WITH A REAL-LIFE STRESSOR:
A MULTIMODAL COMPARISON OF FIT AND UNFIT MALES

by

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Abstract

Aerobic fitness is associated with several psychological and physiological adaptations which possibly allow psychological stressors to be coped with more efficiently. The present experiment examined whether aerobic fitness mediates the psychological and physiological responses to a real-life psychological stressor. The stressor task involved carrying out a 15-metre rappel for the first time. A further objective was to examine if the Type A Behaviour Pattern also mediated the response. Subjective anxiety, heart rate, norepinephrine, epinephrine, and cortisol were monitored in 9 fit and 9 unfit male subjects, (age range 21 - 33), at various intervals before and following exposure to the stressor task. Multivariate analysis of variance with repeated measures analysis was used to analyse the data. All measures increased markedly in both groups during the stressor. Fit subjects had lower levels of heart rate and tended to recover to baseline more quickly post-stressor. Unfit subjects reported less subjective anxiety from pre- to post-stressor, and then recovered more slowly during post-stressor rest. No endocrinological differences were shown, and no differences between Type A and Type B groups were revealed. This suggests that aerobically fitter individuals may be capable of faster recovery on heart rate and subjective anxiety, and therefore potentially have a more adaptive response showing better coping efficiency. These results, and the lack of endocrinological and Type A/B differences are discussed in light of current research.
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Introduction

Physical fitness has been postulated as having a beneficial effect on one's psychological well-being (Browman, 1981; Folkins & Sime, 1981; Ledwidge, 1980). The rationale for this has been largely anecdotal. However, psychological stressors have been determined to elicit similar physiological responses in the organism as physical training. This parallel response has been identified as a possible mediator of the psychological benefits of physical fitness which is reported to have a possible 'cross-adaptation' effect resulting in a higher threshold of vulnerability to the negative aspects of psychological stressors (Dienstbier et al., 1981; Ledwidge, 1980; Schwartz, 1981).

The ability to cope has been associated with rapid rates of recovery after exposure to stressors, physical or psychological, and may therefore be affected by the level of fitness of the individual (Sinyor, Schwartz, Peronnet, Brisson, & Seraganian, 1983). Personality factors have also been identified as mediators of the ability to cope (Roessler, Burch, & Mefferd, 1967). The Type A behaviour pattern, which is defined as an action-emotion complex involving an aggressive, chronic struggle to achieve more and more in less and less time (Friedman & Rosenman, 1974), is closely linked to coping and stress in its role as a predictor of susceptibility to coronary heart disease (Glass, 1977) and also as a coping style (Pittner, Houston, & Spiridigliozi, 1983; Vickers, Hervig, Rahe, & Rosenman, 1981). It is therefore suggested that high levels of aerobic power may enhance the ability of an individual to cope with psychological stressors. Furthermore, individuals displaying Type A behaviour, in conjunction
with low levels of aerobic power, may have the least efficient coping ability.

Cannon (1939) stated that the organism attempts to maintain internal stability through co-ordinated physiological processes and defined this as 'homeostasis' which is a relatively stable condition that may alter as a consequence of its environment. Stimuli such as pain, fear and anger initiate these physiological changes so that the body can cope with the stressors (Cannon, 1953). Prolonged and unnecessary activation of the physiological responses may have deleterious effects (Cannon, 1953; Glass, 1977). Several studies have developed this rationale into a definition of coping which equates rate of recovery of physiological and psychological measures towards a baseline with coping efficiency (Johansson, 1976; Frankenhauser, 1980; Frankenhauser & Rissler, 1970). Coping should therefore be measured psychologically and physiologically in order to identify overall trends that may occur in response to a stressor (Lazarus & Folkman, 1984; Mason, 1968). Lazarus and Folkman (1984) suggested that the identification of physiological response patterns linked to attendant emotional states is the most appropriate index of coping.

Physical fitness has been identified as a possible mediator of coping efficiency through the physiological changes that occur as a result of the increased demands on the organism due to training. High levels of aerobic power are associated with changes in specific physiological functions both at rest and while working (Matthews & Fox, 1976; Tharp, 1975; Winder, Hickson, Hagberg, Ehsani, & McLane, 1979). Fitter individuals tend to display more efficient physiological
functioning through changes such as increased stroke volume, increased ability to utilise oxygen and lower levels of epinephrine, norepinephrine, and cortisol both at rest and while exercising. An important trend for all these variables was that in fitter individuals, after exercise at the same relative workload as less fit individuals, recovery back to resting levels was more rapid. These changes have also been associated with general increases in feelings of psychological well-being (Gillick, 1984; Goldwater & Collis, 1985) and with the theory of cross-adaptation (Schwartz, 1981). There is, therefore, accumulating evidence that high levels of aerobic power may mediate the response to psychological stressors and thus enhance coping efficiency both psychologically and physiologically.

A number of studies have investigated this thesis (Hollander & Seraganian, 1984; Hull, Young, & Ziegler, 1984; Keller & Seraganian, 1984; Sinyor et al., 1983; Schwartz, 1981). The responses to psychosocial stressors between groups with differing levels of aerobic power were measured using a range of psychological and physiological indices. Measures such as heart rate, blood pressure, cortisol, epinephrine and norepinephrine were used. Although evidence was mixed, some support was established for the hypothesis that high levels of aerobic power result in a faster rate of recovery on psychological (e.g., subjective anxiety) and physiological (e.g., heart rate, epinephrine) measures after exposure to psychosocial stressors.

Personality dimensions are also thought to play an interactive role with fitness and coping efficiency (Kobasa, Maddi, & Puccetti, 1982; Roessler et al., 1967). Lake, Suarez, Schneidermann, and Tocci
(1985) investigated the mediating roles of Type A behaviour pattern and physical fitness on an individual's psychophysiological reactivity to a range of laboratory stressors. Sedentary Type A individuals recorded greatest reactivity over a period of time on measures of blood pressure and myocardial oxygen consumption in response to the stressors. Exercise has also been shown to reduce the magnitude of certain Type A components and thus reduce the physiological hyperactivation in stressful situations (Blumenthal, Williams, Williams, & Wallace, 1980). A further variable, control, has been identified as playing a key role in this interaction (Glass, 1977). Type A individuals, who perceive themselves to be in uncontrollable situations, become hyper-responsive and are thus less able to cope with stressful stimuli as a Type B counterpart who feels in control (Contrada et al., 1982). The Type A personality in an uncontrollable situation has been shown to react with a higher level of sympathetic activation than his/her Type B counterpart by having increased measures of blood pressure, heart rate, epinephrine, norepinephrine and cortisol. Therefore, this personality type is possibly predisposed to slow rates of recovery and thus poor coping ability. For an extended review of the literature see Appendix A.

All of the studies cited have been conducted under laboratory conditions using cognitively based psychosocial stressors. Field studies in this area are relatively sparse (Goldstein et al., 1982; Ursin, Baade, & Levine, 1978). Mason (1968) and Sanders (1983) both emphasised the need to conduct some investigations in naturalistic settings. Ethical constraints are rapidly reached in the laboratory and
therefore many of the tasks come into question regarding their ecological validity. Dimsdale (1984) acknowledged the poor control associated with field settings but affirmed the benefits of greater provocation and more realistic stressors.

The main objective of this study was to examine the relationship between level of aerobic power and efficiency of coping with an acute real-life stressor. Novice rappellers, both aerobically fit and unfit, completed a 15-metre rappel. Measures of subjective anxiety, heart rate, epinephrine, norepinephrine and cortisol were taken at various time intervals before and after the task. It was hypothesised that high levels of aerobic power compared to low levels would result in a faster rate of recovery of psychological, physiological and hormonal measures after exposure to an acute stressor.

A further objective was the investigation of the interaction between Type A or B behaviour, and rate of recovery. Subjects were classified as Type A or B individuals to assess if this factor was related to their coping efficiency. It was hypothesised that Type A's would display the slowest rates of recovery whereas Type B's would recover the most quickly.
Method

Subjects

The subjects were 27 volunteer males, with no previous rappelling experience, from the University of British Columbia campus community. Eighteen were registered students, and 9 were working full time in various jobs on campus. They either participated regularly in aerobic activities or were relatively sedentary.

The final sample consisted of 18 subjects due to losses from technical difficulties with the intravenous catheter (n =7) and contaminated specimens (n =2). The groups consisted of: fit (n =9) and unfit (n =9), and Type A (n =8) and Type B (n =10). Type A and B's were evenly distributed within the fit and unfit groups: Type A - fit (n =4), unfit (n =4), and Type B - fit (n =4), unfit (n =6).

Dependent Measures

Self-report measures. Type A behaviour pattern was measured using the Jenkins Activity Survey - Form C (Jenkins, Rosenman, & Zyanski, 1979). Only the Type A/B scale was scored. Raw scores were converted to standard scores (M = 0, SD = 10), and a median split of 0 was used to categorise each subject as Type A or Type B. Subjective anxiety was measured using a mood checklist used by Hull et al. (1984). This is a 5-point scale with 8 sets of adjective semantic differentials. The scores from each item were summed and an overall index of anxiety extrapolated.

Control was measured with a visual analogue form of a 5-point
Likert scale used by Folkman and Lazarus (1985). Control is considered to be an important variable in the initiation of Type A behaviour (Glass, 1977) and was therefore assessed in order to carry out a manipulation check.

**Heart rate.** Heart rate was monitored by a Microcomputer Sport Tester (Polar Electro, Finland). The transmitter was attached around the subject's chest and the microcomputer to the wrist. An electrocardiographic signal was sent from the transmitter to the receiver. The average value of the heart rate was presented digitally approximately every 5 seconds, and a mean for each 30 second interval was also recorded.

**Aerobic power.** Aerobic power is the rate at which energy can be produced from oxidative processes, and is quantified as the maximum amount of oxygen which can be consumed per unit of time during a progressive exercise test to exhaustion (Thoden, Wilson, & MacDougall, 1983). Aerobic power was assessed using a continuous progressive VO2 max running test on the treadmill. After a warm-up of 5 mph for 3 minutes the test was started and the speed increased 1/2 mph each minute until volitional fatigue. Expired gases were continuously sampled and analyzed by a Beckman Metabolic Measurement cart interfaced with a Hewlett Packard 3052A data acquisition system for 15 second determinations of respiratory gas exchange variables. VO2 max was calculated by taking the mean of the four highest consecutive 15 second VO2 max values (Rhodes & McKenzie, 1984).

**Catecholamines and Cortisol.** Catecholamines and cortisol respond to psychological and physiological stressors, and were
identified as being accurate indicators of an individual's stress response by Cannon (1939) and Selye (1956) respectively. Catecholamines are released into the blood through the adrenal medullae and remain highly active for 10 to 30 seconds followed by decreasing activity for 1 to several minutes. The mass discharge of catecholamines as a part of the sympathetic stress reaction results in an increase of: blood flow to the working muscles, cellular metabolism, mental activity, arterial pressure, and blood glucose. These are all part of the activation of the sympathetic nervous system which enables the individual to respond to the stressor. Cortisol is secreted into the blood through the adrenal cortex and has a half-life of 60 minutes. It results in an increase of glucose production, and a decrease in glucose utilization as a result of an increase in the mobilization of free fatty acids from adipose tissue. This benefits an individual exposed to psychological or physical stressors by increasing the amount of fuel available for activity in fight or flight situations.

(1) Baseline Session. A 21G butterfly catheter was inserted into an antecubital vein and the line flushed with saline and heparin to maintain patency. A 10 cc sample was withdrawn after a 20 minute period and the catheter then removed. (2) Stressor Task. A 20G Jelco catheter was inserted into a forearm vein and the line flushed with saline and heparin. An intermittent infusion plug was attached to the end of the line to allow samples to be drawn periodically for 65 minutes. (The catheter was wrapped in gauze during the rappel to prevent it from being pulled out). The samples were stored on ice, centrifuged at the end of the session, and the plasma then stored at -80 C. Plasma was
assayed for epinephrine, norepinephrine and cortisol (see Appendix C for details). The catecholamines were assayed in the Department of Pharmacology at the University of British Columbia, and cortisol was assayed in the Laboratory of the University Hospital.

See Appendix B for full descriptions, and validity and reliability data on the dependent measures, and the measure of control.

Procedure

Subjects were enlisted through poster advertisement around the campus of the University of British Columbia. They were screened on initial contact as to their suitability to participate in the study. Each subject was asked about his level of fitness, rappelling or rock climbing experience, and previous history of blood donation. A total of 36 subjects were screened of which 30 were selected for testing. Two were discarded due to a history of blood donation problems, and 4 were discarded due to a relatively high level of experience in either rock climbing or rappelling. Three subjects from the final 30 were discarded due to difficulties experienced in obtaining blood during the baseline session. Therefore 27 subjects completed the experimental protocol. Technical difficulties with the intravenous catheter resulted in the loss of the blood samples of a further 7 subjects. Contaminated specimens resulted in the loss of a further 2 subjects. Therefore the final sample size was 18.

Subjects were tested individually on three separate days.

Session 1. Subjects reported to the laboratory at either 0900 or 1015 and had been instructed to refrain from taking any drugs, alcohol, caffeine, and vigorous exercise for a 12 hour period prior to their
reporting to the laboratory. After a detailed explanation of the procedures and risks subjects signed two informed consent forms: one regarding the study as a whole, and one specific to the VO2 max treadmill protocol. They next completed a demographics questionnaire concerning their exercise habits and adventure sports participation. After having their height, weight, and blood pressure recorded, they stretched and then completed the VO2 max treadmill test.

Session 2. Subjects reported to the laboratory between 0900 and 1200 no later than two weeks after Session 1. They reclined on a table while the intravenous catheter was inserted. They then sat up, moved to a desk, and completed the Jenkins Activity Survey. After a period of 20 minutes had elapsed from insertion of the catheter, 10 ml of blood were withdrawn. The heart rate telemeter was attached to the subject's chest and a resting heart rate was taken. The subject then completed the subjective anxiety checklist. This session represented the baseline for heart rate, subjective anxiety, and hormone measures.

Session 3. Subjects reported to the laboratory between 0900 and 1200 no later than two weeks after Session 2. They reclined on a table while an intravenous catheter was inserted into a forearm vein. The heart rate telemeter was attached to the subject's chest and the receiver to the wrist on the same arm as the catheter was inserted. The subject then walked 400 metres with the experimenter and intravenous technician to the rappel site. An explanation and demonstration of the rappel was given and any questions answered. After 20 minutes had elapsed from insertion of the catheter; heart rate, subjective anxiety, and level of control were recorded. Ten ml of blood were also
withdrawn. (This sample was taken at the base of the rappel wall due to the difficult access to the rappel platform, and the associated logistics of moving the intravenous technician and the blood samples up and down the wall). The subject then completed the rappel (approximately 2 to 3 minutes in duration) after which heart rate, subjective anxiety, and level of control were immediately recorded. Ten ml of blood were withdrawn. The subject, experimenter, and technician returned to the laboratory. On arrival the subject sat in a comfortable chair and was shown a wildlife video tape as a distraction and to aid relaxation. Two further measures of heart rate, subjective anxiety, and 10 ml of blood were taken at 15 and 30 minute intervals after completion of the rappel. All blood samples were placed on ice and on completion of the session were centrifuged and the plasma stored at -80 C.

The catheter and heart rate telemeter were removed from the subject. The subject was then fully debriefed as to the purpose of the study and any questions answered.

Data Analysis

Two-way repeated measures multivariate analysis of variance (MANOVA) with trend analysis was used to compare the reactions between the fit and unfit group (condition) over five sampling points (time). Trend analysis was used in order to interpret the type of pattern each dependent variable displayed over time. Condition was considered a between subject factor while time served as a within subject factor. A trend analysis was performed on the five sampling points (time 1 to 5).
The large number of dependent variables and the relatively small subject size per cell necessitated the clustering of the dependent variables for separate analysis. Therefore 2 MANOVAs and 1 ANOVA with repeated measures and trend analysis were selected. This represented the best way to achieve optimal statistical power with the least inflation of Type I error. The dependent variables were grouped as follows for analysis: (a) heart rate and subjective anxiety, (b) epinephrine and norepinephrine, (c) cortisol. The same analysis was completed using Type A and B as the between subject factor (type). Two-way repeated measures analysis of variance (ANOVA) was used for cortisol for both condition and type over time. Heart rate was grouped with subjective anxiety in order to maximise the information that could be gained from these two dependent variables. Heart rate is responsive to a number of other variables such as attention and workload, and therefore, by grouping it with subjective anxiety, potential interactions between these two variables could be assessed and the affect of other variables could to an extent be controlled. Norepinephrine and epinephrine were grouped as they have a similar physiological function in response to psychological stress. Cortisol responds to slightly different components of psychological stressors than catecholamines and also has a different pattern of response as a function of increased physical fitness, and was therefore analysed in isolation.

ANOVA with repeated measures was used to perform a manipulation check on the level of perceived control for both condition and type at sampling points 2 and 3. (These represent pre- and post-stressor times
respectively).

Missing or contaminated values resulted in the omission of all data from that subject.
Results

Group Comparability

Two groups were formed based on VO2 max scores with a median split of 52.15 ml/kg. The high fit group (n = 13) had a mean VO2 max of 57.79 ml/kg/min (range 52.70 - 68.44, SD = 4.2) while the low fit group (n = 14) mean was 47.93 ml/kg/min (range 39.79 - 52.13, SD = 3.6). This resulted in two groups with significantly different measures of aerobic power (t (25) = 6.56, p < .001). The number of hours spent training aerobically per week ranged from 0 to 24. Although the two groups fall into the fit category of a normal population, the mean number of hours spent a week doing physical training was twice as high for the fit group (Fit M = 12.4, Unfit M = 6.4). The mean age for the fit group was 24.7 years (range 21-29, SD = 2.4) and for the unfit group was 27.1 (range 21-33, SD = 4.1). Five subjects were active SCUBA divers, one had taken a hang-gliding course, one had taken a weekend's parachute course, and five others regularly went hiking or canoeing. These subjects were evenly distributed within the fitness and Type A/B groups.

A manipulation check was carried out on the degree of control each subject perceived immediately prior to and following the rappel. Two 2 x 2 (Group x Time) ANOVA's with repeated measures on time were used to determine if there were any differences between the high and low fit groups and Type A and B groups on levels of perceived control. Means and standard deviations appear in Tables 1 and 2. There were no significant interactions for fitness (F <1), or for Type (F <1) across the two time periods. There were also no significant main
effects for either fitness or Type (F < 1). See Table 3.

**MANOVA Analyses**

Two 2 x 5 (Group x Time), repeated measures with trend analysis on time, MANOVA's were used to evaluate possible differences in levels of reactivity within both the fitness and Type A/B groups on the dependent measures: (1) heart rate (HR) and subjective anxiety (SA), (2) norepinephrine (NE) and epinephrine (E). Means and standard deviations for HR and SA appear in Tables 1 and 2, and for NE and E in Tables 4 and 5.

**Fitness.** The MANOVA on HR and SA revealed a significant interaction for groups by time (F(8,9) = 4.0, p < .03). Therefore univariate ANOVA's were examined and revealed a significant interaction for subjective anxiety (F(4,13) = 2.63, p < .054) while heart rate was non-significant (F(4,13) = 1.01, p < .244). (Univariate F scores reported are the Huynh-Feldt adjusted values). An examination of the polynomial trends for SA indicates no significant interactions at the conventional level (p < .05). However due to the exploratory nature of the study it was judged important to examine the trends which approached significance. Both Linear (F = 3.66, p < .074) and Quartic (F = 3.78, p < .069) polynomial trends approached significance suggesting a difference between the fit and unfit groups for these patterns. Examination of Figure 1 shows that the fit group recover more quickly from completion of the rappel to the end of the recovery while the unfit group appear to reduce anxiety more rapidly from the start to the end of the rappel.

The trend analysis for the interaction on heart rate revealed one
significant polynomial effect: Cubic ($F_{(1,16)} = 5.15, p < .037$).

Examination of Figure 2 reveals that the fit group have a lower heart rate level throughout the stressor and recovery periods, and possibly return to baseline more quickly than the unfit group following the stressor task.

A MANOVA main effect for time was found ($F_{(8,9)} = 16.88, p < .001$), and both follow-up univariates were significant, HR ($F_{(4,13)} = 16.97, p < .001$) and SA ($F_{(4,13)} = 6.91, p < .01$). Examination of Figures 1 and 2 indicates that over time both groups reacted to the stressor and then gradually recovered towards baseline. A significant main effect for fitness was also revealed ($F_{(2,15)} = 6.25, p < .011$). The univariate was significant for HR ($F_{(1,16)} = 8.26, p < .011$) but not for SA ($F_{(1,16)} = 2.79, p < .115$). Therefore, overall the fit group have a lower heart rate than the unfit group.

There were no significant MANOVA interactions for catecholamines ($F_{(8,9)} = 1.03, p < .48$). However, a MANOVA main effect for time was revealed ($F_{(8,9)} = 15.89, p < .001$). Follow-up univariate ANOVA's were examined and both dependent measures were significant: NE ($F_{(4,13)} = 18.78, p < .001$), and E ($F_{(4,13)} = 15.01, p < .001$). An examination of the means indicates that the catecholamines reacted to the stressor and then returned towards baseline for both groups. See Figure 3 for E score means. No significant main effect for fitness was found ($F < 1$). See Table 6 for a summary of significant MANOVA, univariate, and trend tests.

Type. MANOVA for HR and SA revealed no significant interaction ($F < 1$). However, there was a significant main effect for time ($F_{(8,9)}$)
17.38, \( p < .001 \)). The follow-up univariate for HR was significant (\( F(4,13) = 16.52, p < .001 \)) while SA approached significance (\( F(4,13) = 5.67, p < .073 \)). An examination of the means (see Table 2) indicates that both groups reacted to the stressor and recovered with time. No significant main effect for Type (\( F < 1 \)) was revealed.

MANOVA revealed no significant interaction for catecholamines (\( F < 1 \)). The MANOVA main effect for time was significant (\( F(8,9) = 11.40, p < .001 \)). Follow-up univariate ANOVA's were examined and both dependent measures were significant: NE (\( F(4,13) = 16.87, p < .001 \)) and E (\( F(4,13) = 13.54, p < .001 \)). This indicates that both Type A and B groups responded to the stressor with elevated levels of catecholamines, and then recovered towards baseline over the course of the rest period. See Figure 4 for E score means for Type A/B. The main effect for Type was not significant (\( F < 1 \)). This suggests that neither Type A or B groups had a different reaction to the stressor. See Table 7 for a summary of significant MANOVA, univariate, and trend tests.

Cortisol. Two 2 x 5 (Group x Time), repeated measures with trend analysis on time, ANOVA's were performed for the dependent variable cortisol for fitness and Type groups. No significant interactions were found for either fitness by time (\( F < 1 \)) or for Type by time (\( F < 1 \)). These data show that the groups did not change differentially over time. Significant time main effects were revealed for both groups: fitness (\( F(4,13) = 7.70, p < .001 \)) and Type (\( F(4,13) = 7.85, p < .001 \)). An examination of the means (Tables 4 and 5) revealed that in both groups cortisol reacted to the stressor and then returned to baseline levels during the recovery period. There were no group main
effects for either fitness ($F < 1$) or Type ($F < 1$). See Table 8.

**Correlation.** The correlation matrix for Condition, Type and all dependent variables revealed few high (> .50) correlation coefficients between differing variables. This highlights the lack of relationships found between the psychological and physiological measures. (See Table 9).
Discussion

In general this study finds weak support for the hypothesis that high levels of aerobic power, compared to low levels, are positively related to coping efficiency following exposure to an acute real-life stressor. Due to the relatively small sample size, results and interpretations should be considered with caution. The study should be treated as exploratory in nature owing to its field setting and design. The findings will be discussed in light of current research, and suggestions made concerning the direction of future research in this area.

It is pertinent to discuss one of the limitations of the study before examining the results. The fit and unfit groups, whose max VO2 means were 57.79 and 47.93 ml/kg/min respectively, do not constitute groups representative of a normal fit and unfit population. Statistically the two groups measures of aerobic power are significantly different but, with regards to a general population, they are both highly fit. Ismail, Falls, and MacLeod (1965) developed a range of criterion for physical fitness tests using a sample of 93 males with a mean age of 36. The mean max VO2 was 39.46 ml/kg/min determined from a maximal treadmill test. This differs substantially from the median split of this study, 52.15 ml/kg/min. Other studies in this area of research have reported high and low fit means of 60.17 and 42.33 ml/kg/min (Lake et al., 1985), and 69.1 and 32.8 ml/kg/min (Sinyor et al., 1983). Both these studies used sub-maximal tests to predict max VO2 which have a tendency to overestimate the values of the very fit and the very unfit (Matthews & Fox, 1976). The use of a
maximal test, in conjunction with a physically oriented stressor task, appeared to attract only relatively high fit subjects. The distribution of all subjects into a fit population, with 'unfit' being a relative description, poses a limitation on the testability of the hypotheses presented.

The interaction of subjective anxiety, and polynomial trend for heart rate were significant between the fit and unfit groups suggesting that the fit recovered more quickly after completion of the stressor task on subjective anxiety and heart rate (see Figures 1 and 2). The mean baseline heart rate for the fit group was 52.6 bpm and for the unfit group was 62.9 bpm. The bradycardia displayed in the fit group is a common finding in trained athletes (Guyton, 1980) and has been replicated in other similar studies (e.g., Lake et al., 1985). The difference found during the recovery period between fit and unfit groups is similar to other studies (Hollander & Seraganian, 1984; Schwartz, 1981; Sinyor et al., 1983). It is important to note that the overall magnitude of response for the fit group was significantly lower than the unfit group, and this possibly reflects a more healthy response as a smaller workload is placed on the individual.

Subjective anxiety scores before and after the stressor reveal that the high fit decreased less rapidly than the low fit. This is possibly representative of a maladaptive response for the low fit group as an increase of activation during the stressor is associated with an adaptive response (Frankenhauser, 1980; Ursin, 1982). Furthermore Cannon (1953) suggested that a departure from the relatively stable condition of homeostasis in situations such as pain and fear is
necessary in order to enable the organism to cope, thus supporting the hypothesis that in this situation the unfit group had a less adaptive response than the fit group during the stressor task on the measure of subjective anxiety. A pattern of dissociation also occurs between the pre and post stressor points for measures of heart rate and subjective anxiety. Both groups increase on heart rate while their subjective anxiety falls. This dissociation is especially pronounced for the unfit group as their anxiety drops more rapidly between these two points than the fit group. This dissociation perhaps reveals that heart rate is not directly reflecting level of anxiety during this period, and is increasing due to other factors such as attention and workload.

The pattern of subjective anxiety scores approximates the heart rate pattern during the recovery period for the fit group, and for the initial rest period for the unfit group. The dissociation experienced during the stressor task is now removed during the recovery period (See Figures 1 and 2). This is interesting as other studies have not found differences in subjective mood states during recovery (e.g., Schwartz, 1981; Sinyor et al., 1983). It is possible that the fit group were more aware of their physiological activity and thus reported their psychological state as a function of this (Folkins & Sime, 1981). In addition increased levels of fitness have been shown to result in increased self-esteem, self-efficacy and feelings of subjective well-being (Folkins & Sime, 1981; Ledwidge, 1980). These effects may also directly influence the fit group's perception of the situation on completion of the stressor.

The heart rate and subjective anxiety results should be viewed with
caution, and require replication.

Endocrinological reactivity failed to reveal any differences between the fit and unfit groups. Examination of the means (see Table 4) reveals that both groups peaked immediately following the stressor for NE and E, and then made a gradual recovery towards baseline levels. (See Figure 3 for mean epinephrine scores for fitness). The cortisol data shows a similar pattern for the means except the fit group peaked immediately before the stressor and then started to return towards baseline. These results are consistent with other studies examining fitness related differences in endocrinological reactivity to a psychological stressor (e.g., Hull et al., 1984).

The lack of catecholamine and cortisol reactivity differences also occurred for the Type A and B groups, and one possible reason for explaining this is common to both groups. (See Figure 4 for mean epinephrine scores for Type A/B). The main effects for time were significant for all physiological variables in the groups thus indicating a general sympathetic activation took place. In addition subjective anxiety only differed at one interval for fit and unfit groups and remained the same for Type A and B groups, thus suggesting that perception of the stress induced by the task did not differ substantially between groups. Frankenhauser (1981) highlighted the fact that catecholamine and cortisol responses are determined by the cognitive appraisal of the situation and its emotional impact rather than by its objective characteristics. The nature of the stressor is therefore important and is to a large extent determined by the values and attitudes of the individual (Frankenhauser, 1981). Several of the
subjects in the study had previous experience in adventure activities, and all were obviously predisposed to volunteer for a stress study. The stressor resulted in a response but apparently did not elicit significant enough differences between the groups in perception of the stressor to affect the endocrinological reactivity.

In addition to there being a lack of endocrinological differences between Type A's and B's there were also no heart rate or subjective anxiety differences. Apart from the aspect of perception discussed above, the question arises whether the stressor task elicited Type A behaviour. The definition of the TABP requires that a specific external stimulus is a pre-requisite for its initiation (Friedman & Rosenman, 1974). A number of studies have outlined the nature of the stressor that results in the initiation of TABP. Houston (1983) reviewed a range of tasks including 'solitary tasks', and concluded that differences between Type A and B reactivity only occurred when the studies included pressure to perform well, a lack of control, and punishment avoidance situations. Glass (1977, 1983) emphasised the role of control as being central to the onset of Type A behaviour. Lundberg (1982) concluded that high levels of challenge were a major influence on TABP.

The aspects of control (Glass, 1977) and competition (Houston, 1983) appear to be critical catalysts for the initiation of TABP. Control was shown not to differ immediately before and following the stressor task between groups, and no external stimulus was provided to induce competition or performance expectation in this study. It therefore appears that TABP was not elicited, and thus no inter-group differences occurred.
These results are consistent with several studies which have failed to note differences between Type A and B subjects (Gastorf, 1981; Hyppa, Aumola, Lahtela, Lahti, & Marnieni, 1983; Lake et al., 1985). Hyppa et al. (1983) used a sedentary computer-based task to elicit reactivity in Type A and B individuals. There were no differences on measures of NE, E, and C, and subjects reported a state of well-being and a feeling of control. The authors concluded that the task did not elicit TABP, and that the subjects coped with the stressor task. This conclusion is appropriate to this study. Both groups (condition and type) demonstrated an initial activation on presentation of the stressor, and then a gradual recovery towards Baseline levels of psychological and physiological measures. Activation necessary to cope with the stressor followed by a return to a state of homeostasis took place thus indicating efficient coping in both sets of groups.

Two recommendations for future research in this area arise in light of this study. First, specific groups involved in acute stressor exposure, e.g., military groups, commercial divers, police forces, can benefit from research conducted with a similar design to the current study. However, a large subject sample is needed to absorb the wide variance often encountered in psychophysiological data, and to ensure valid results.

Second, long-term 'in-vivo' studies examining subjects in their work place are more pertinent for determining exact psychophysiological reactivity patterns and possible pathogens of CHD (Ursin, 1982). Portable, constant sampling blood withdrawal pumps (Dimsdale, 1983) make this type of longitudinal research feasible, and permits
examination of specific populations while being exposed to their usual daily stressors. This type of research would require a stringent design in order to overcome the control problems associated with a field study of this nature.

Both types of study should include a well-administered training programme for the experimental group, and a suitable non-physical activity such as reading for the control group to allow causal interpretations as a result of increased physical fitness.
References.


28

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Pittner, M.S., & Houston, B.K. (1980). Response to stress, cognitive


Rosenman, R. H., Brand, R. J., Jenkins, C. D., Friedman, M., Strauss, R., & Wurm, M. (1975). Coronary heart disease in the Western Collaborative Group study: final follow-up experience of eight and
a half years. *Journal of the American Medical Association*, 233, 872-877.


KEY TO VARIABLE AND TIME ABBREVIATIONS USED IN SUBSEQUENT TABLES AND FIGURES

NE .............................................. Norepinephrine (pg/ml)
E ............................................... Epinephrine (pg/ml)
C ............................................... Cortisol (pg/ml)
SA ............................................... Subjective anxiety
HR ............................................... Heart rate (bpm)
CTL .............................................. Control
BASE ............................................. Baseline
PRE ............................................... Prior to rappel
POST ............................................. After rappel
REST 1 ......................................... 15 mins after rappel
REST 2 ......................................... 30 mins after rappel
Table 1

Means and Standard Deviations of Heart Rate, Subjective Anxiety, and Control for Fitness

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Table 4

Means and Standard Errors of Norepinephrine, Epinephrine and Cortisol for Fitness

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Table 5

Means and Standard Errors of Norepinephrine, Epinephrine and Cortisol for Type A/B

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Table 6
Summary of Significant Multivariate, Univariate, and Trend Tests for Fitness

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a Huynh-Feldt Adjusted Value
Table 7

Summary of Significant Multivariate, Univariate, and Trend Tests
for Type A/B

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Table 8

ANOVA's for Cortisol for Fitness and Type A/B

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Figure 1. Mean SA Scores for Fitness.
Figure 2. Mean HR Scores for Fitness.
Figure 3. Mean Epinephrine Scores for Fitness.
Figure 4. Mean Epinephrine Scores for Type A/B.
Appendix A

Review of Literature

Coping

Theoretical Background. The person-environment relationship, in the context of coping, is a dynamic, transitory state which involves emotional and cognitive changes as level of appraisal, physiological responses, and demands vary (Burchfield, Stein, & Hamilton, 1984; Lazarus & Folkman, 1984). Coping measurements should therefore reflect not only this state of dynamism but also the multimodal responses of the organism. Lazarus and Folkman (1984) emphasised the need for researchers to look for specific patterns in the physiological response and link these to the associated emotional states. Mason (1968) also pointed out that the investigator should establish the quality of the emotional reaction of the individual at the same time as assessing the physiological response.

The process-oriented approach to the assessment of coping incorporates the multimodal measurement theory. This model of coping is not limited to a specific style or trait but emphasises a constant changing in behaviour with the aim of either altering the perceived implications of the situation or combating the negative emotions produced (Ray, Lindop, & Gibson, 1982). This type of schema therefore differs from more traditional models such as approach/avoidance or repression/sensitisation and is not restricted by an unidimensional continuum. It also appropriates multimodal measurements to assess the on-going reaction over a period of time and the varying response of the individual. Lazarus and Folkman did not regard coping as limited to a
set style or trait alone and supported the type of process-oriented theory such as that proposed by Ray et al. (1982).

Burchfield et al. (1984) illustrated their model for studying psychological and physiological relationships within the context of test anxiety. Their review of literature in this field yielded support for an interactive model of psychological and physiological processing rather than a parallel model. Highlighted in their conclusions were the need to take several psychological and physiological measures concurrently and to use a within-subjects design with repeated measures over time. These recommendations support the use of a multi modal assessment of coping and the process-oriented approach.

Burchfield et al. (1984) further recommended the measurement of physiological variables as directly as possible. Therefore, instead of simply measuring heart rate, for example, plasma catecholamines should also be measured. The use of endocrinological analysis with hormones such as cortisol and catecholamines has recently become widespread (Ursin et al., 1978; Vaernes et al., 1982). The responses of the sympathetic- and pituitary-adrenal systems to stressors were identified by Cannon (1939) and Selye (1956) respectively. Cannon (1939) developed a theory of homeostasis and the emergency function of fight-or-flight in response to threats to this condition of equilibrium through heightened emotions such as pain, fear and rage. Selye (1956) developed the General Adaptation Syndrome Theory which consists of three stages: Alarm reaction, Resistance and Exhaustion. These stages represent all non-specific changes as they develop with time in response to a stressor. Cannon (1953) regarded the sympathetic-adrenal system as
being the primary response to states of high emotion whereas Selye (1956) regarded the pituitary-adrenal activity as being a general, non-specific response to any stressor. Mason (1968), in the detailed review of psychoendocrine research, encouraged the investigation of a broad range of endocrine systems rather than limiting the scope to a singular hormone. While the specific nature and roles of each hormone are acknowledged, Mason (1968) also noted the links that exist between them.

The work of Cannon (1939) forms the basis for a definition of coping. Although the definition is derived from research centered on the sympathetic-adrenal system it is equally applicable to the pituitary-adrenal system, heart rate and also subjective ratings of stress-related emotions. Cannon (1939) suggested that the organism maintains internal stability through co-ordinated physiological processes and defined this as a state of 'homeostasis'. This condition is relatively constant but may vary as a consequence of the organism's environment. In situations such as pain, fear and anger the body undergoes changes which include increased blood sugar, increased adrenalin and increased respiratory rate to enable the organism to cope with the physical demands it is subjected to after perception of the emotional stimuli (Cannon, 1953). While these reactions may be essential for survival of the organism in the short-term, their long-term activation after disappearance of the stimulus or their persistent activation has been associated with possible increases in psychosomatically induced illness (Cannon, 1953; Glass, 1977; Johansson, 1976). Frankenhauser (1980) referred to this phenomenon as a
'slow unwinding' which reflects a maladaptive overresponse. In contrast, those who recover quickly, have an 'economic response' and tend to be better balanced psychologically (Frankenhauser, 1980). It is therefore hypothesised that the faster the return to a condition of stable homeostasis after exposure to an acute emotional stressor the more efficient is the coping and the less likely is the development of pathological functions.

Several studies have developed this idea and used this definition of coping (Frankenhauser, 1980; Frankenhauser & Johansson, 1976; Frankenhauser & Rissler, 1970; Johansson, 1976). Johansson (1976) carried out a study in which the aim was to observe differential rates of recovery in adrenalin after exposure to a stressor and to attempt to explain the differences through intraindividual variation. A rapid rate of recovery was associated with an efficient adaptation to the stressor. Sixteen male subjects performed an audiovisual-conflict task and a mental arithmetic test during an ordinary working day. The test was completed on two occasions: once before a three week vacation, and again after the vacation. These two situations were hypothesised to represent a fatigued and stressed state, and a relaxed and balanced state respectively. Urinary measurements of adrenalin and noradrenalin were taken and simultaneous mood ratings were also completed. The Eysenck Personality Inventory (Eysenck & Eysenck, 1964) was also administered to each subject individually a few days after the last testing session. There were no significant differences on either mood rating or catecholamine rates of recovery between the two testing sessions. A sub-group of 5 subjects showing the most extreme reactions
was analysed and this yielded significant results supporting the hypothesis of increased recovery rates after the vacation. However, these results should be viewed with caution due to the low statistical power of such a small sub-sample. There were also a number of paradoxical catecholamine increases between the control and experimental trials before and after the vacation thus suggesting a possible fault in the design of the study and the validity of the relaxation treatment. Furthermore some significant results were obtained to support the hypothesis by averaging the data across individuals while there was large interindividual and intraindividual variation. This was also statistically questionable in light of the individual data obtained which showed no individuals who decreased rapidly.

Frankenhauser and Johansson (1976), in a similar study, looked at the heart rate and catecholamine response and performance changes over two different task demands: single and double conflict tasks. Three groups of 16 subjects participated and heart rate, urinary catecholamines and a mood rating were used as the measures. The different levels of task demand were reflected in the intensity of the heart rate and catecholamine response. The double-conflict task resulted in a slower return to baseline on the physiological measures and the rapid decreasers showed a better psychological adjustment on the rating scales than the slow decreasers.

The literature therefore presents some support for the theory of rapid returns to baseline as reflecting more efficient coping. The studies reviewed have several design faults: small subject size, a
large number of uncontrolled variables, and the use of urinary as opposed to plasma catecholamine sampling for moment-to-moment analysis. Burchfield et al. (1984) listed a number of prerequisites for methodology in this field of research which would improve the validity of the results. These included the simultaneous measurement of several physiological and psychological variables as directly as possible, a within-subjects design with repeated measures over time and the use of plasma sampling for accurate transitory analysis. Coping can be accurately assessed in the context of a rapid return to baseline on psychological and physiological measures if certain recommendations are followed.
Physical Fitness and Coping

Introduction. Physiological reactivity to physical exercise is to some degree similar to the reactivity to psychological stress, and therefore, through a process of habituation, may improve the capability of the organism to deal with the stress (Dienstbier et al., 1981; Ledwidge, 1980). This section reviews the effects physical training and fitness have on psychological health, and certain physiological and endocrinological variables. Differences that exist between the trained and non-trained are highlighted, and hypotheses made as to how this might affect their ability to cope with psychological stressors.

A high level of physical fitness results in the organism's ability to return quickly to resting levels of heart rate after bouts of exercise (Matthews & Fox, 1976). This may also have an effect on physiological recovery rate after exposure to psychological stressors and thus improve the coping efficiency of the trained as opposed to the untrained. In the late 1950's Michael (1957) proposed that an increased level of fitness would result in an increase in the level of steroid reserves to counter the negative effects of psychological stressors. Other changes that occur with physical training include a lower resting heart rate, an increased stroke volume, an increase in hemoglobin, an improved body composition and favourable lipoprotein profiles (Matthews & Fox, 1976). These changes result in a more healthy individual who is perhaps more capable of coping with the stressors in daily life.

Ledwidge (1980) reviewed the literature which presents aerobic exercise as a possible panacea for the symptoms of anxiety and depression. In fitter individuals it is suggested that the overall
activation to psychological stressors is reduced, and the subsequent recovery is faster than in those who are less fit as based on Selye's (1956) General Adaptation Syndrome theory. Furthermore, Ledwidge hypothesised that the somatic symptoms of strenuous exercise and psychological stressors become assimilated through a process of cognitive relabelling and thus the tolerance for anxiety and depression in the fitter individual is increased. Ledwidge also suggested that exercise is a natural muscle relaxant, promotes sound sleep, reduces the production of lactates which is excessive in anxiety neurotics, and increases the output of norepinephrine which is low in depressives. Folkins and Sime (1981) also reviewed the literature on the effects of physical fitness on psychological well-being and point out that much of the research is speculative, atheoretical and poorly designed. Both Ledwidge (1980) and Folkins and Sime (1981) concluded that more stringent studies are needed to look at many of the assumptions put forward.

**Physical Fitness and Psychological Health.** The psychological benefits accrued from physical training have been well documented (Folkins & Sime, 1981; Gillick, 1984; Ledwidge, 1980). Goldwater and Collis (1985) reported that a group enrolled in a 6 week cardiovascular programme showed a greater reduction in anxiety and a greater increase in measures of general psychological well-being than a control group enrolled in a conditioning programme not specifically related to cardiovascular efficiency. Their design attempted to isolate benefits accrued solely by cardiovascular conditioning as opposed to simply being active with the associated feelings of improved self-esteem.
However, self-selection resulted in a large dropout from the cardiovascular training group and therefore the possible effects of personality were not controlled.

Gal and Lazarus (1975) suggested that an increase in feelings of control are concomitant with being active in the face of a stressor and this often results in reducing threat and distress. Blumenthal et al. (1980) reported that regular exercise can modify some of the psychological and physiological variables associated with high risk coronary heart disease individuals as identified by the Type A behaviour pattern. Roth and Holmes (1985) studied the interaction of varying levels of fitness and exposure to stressors and its effect on subsequent incidence of clinical depression and ill-health. They found that those with higher aerobic fitness had fewer health related problems than those with low aerobic fitness as a result of exposure to daily life stressors.

Physical training also has an effect on the sympathetic- and pituitary-adrenal systems which have been identified as playing an important role in the organism's response to psychological stressors and its subsequent ability to cope (Cannon, 1939; Selye, 1953). Differing catecholamine and cortisol responses to both psychological and physiological stressors between trained and untrained individuals may have an effect on coping efficiency.

Response of the Sympathetic- and Pituitary-Adrenal Systems to Physical Activity. Physical activity has a varying effect on the excitation and inhibition of the sympathetic and pituitary adrenal systems in the physically trained and untrained (Dimsdale & Moss, 1980;
Tharp, 1975). The isolation of the physical activity response is difficult to achieve. This is due in part to the varying responses it stimulates and in part to the attendant psychological factors for which reliable measures are difficult to obtain. The extent to which physical activity produces psychological stress is hard to evaluate and it is this confounding factor which is partly responsible for the mixed evidence presented in regard to hormonal adaptation to physical activity.

The response of the sympathetic-adrenal system to physical activity is not systematic and predictable (Lehmann, Keul, Huber, & Da Prada, 1981; Winder et al., 1979). It is related to the workload, the level of fitness of the individual, the psychological perception of the task, and the variations in blood sampling and assay techniques.

Dimsdale and Moss (1980) reported that levels of norepinephrine (NE) rose threefold while epinephrine (E) rose only 50% after 4 minutes of stair climbing. This finding has been replicated in several other studies (Bloom, Johnson, Park, Rennie, & Sulaiman, 1976; Hartley et al., 1972) and has implications as to the source and type of secretion. Hartley et al. (1972) explained this significantly higher value of NE in response to exercise as a function of its secretion origin which they proposed to be the sympathetic nerves rather than the adrenal gland. E does not appear until heavier workloads when it is stimulated either by glucose deficits and/or the psychological stress of intense physical activity. This has certain implications for the role of fitness in the elicitation of catecholamines as a stress response.

Table 10 presents an overview of the chief stimuli and roles of
catecholamines as a function of physical exercise. The convergence of E and NE at high levels of muscular work can be accounted for not only by the higher demand for energy but also, in the case of E, by the effects of hypoglycemia and its attendant feelings of discomfort.

The removal or disappearance of catecholamines from the blood, or more accurately from the local tissues surrounding the venipuncture site, is less well documented. The rate of recovery back to a baseline measure has been associated with efficiency of coping as the body returns to its homeostatic balance (Hansen, Stoa, Blix, & Ursin, 1978; Schwartz, 1981). The speed of recovery from physical activity, which is significantly faster in the well-trained, may have implications for the speed of recovery from purely emotionally elicited stress.

Tharp (1975) provides an excellent review of the role of glucocorticoids (GC) in exercise. GC consist of hydrocortisone, corticosterone and cortisol. Ninety-five percent of the GC activity results from the secretion of cortisol from the adrenocorticotrophic hormone (ACTH) and therefore plasma cortisol is an accurate indicant of the pituitary-adrenal response to exercise (Guyton, 1980). GC's have three principle functions during exercise: (1) stimulate glucogenesis, (2) mobilize amino acids, (3) mobilize free fatty acids from adipose tissues. All of these functions are theoretically beneficial during muscular exercise as they provide greater supplies of fuel for energy consumption. The similarity of functions between GC's and catecholamines is evident.

GC's therefore contribute to work performance. The exact timing of their activity and further roles they fulfill are also important. A
number of the early studies looking at the effect of physical activity on adrenocortical function produced contradictory results (Hartley et al., 1972; Raymond, Sode, & Tucci, 1972). This was more a function of differing methodologies (e.g., different workloads, different level of fitness of the subjects) rather than the differential trends of cortisol activity during physical exercise.

Davies and Few (1973) examined the effects of physical exercise in 10 healthy male subjects with measures of plasma cortisol (C), tympanic temperature, cardiac frequency and oxygen consumption. The results showed that at 40% VO2 max workload there was a significant decrease in C levels. Diurnal variations were accounted for by incorporating a control group in the study. Raymond et al. (1972) found similar values examining C levels in light muscular exercise in a completely non-competitive setting. The study did find two values raised significantly but the subjects also had significantly higher anxiety rating values. This illustrates the more global stress reactivity pattern often associated with C (Guyton, 1980). Davies and Few (1973) found that at heavier workloads of 60-90% VO2 max there was a varied response of +7.02 ± 4.88 micrograms above baseline. However, the post-exercise changes were more consistent and rose at the 10th minute to a level of +10.64 ± 6.06 micrograms above baseline. The levels then declined consistently for the next hour but did not return to baseline. It is suggested that the critical level for the onset of increased C activity is at 60% VO2 max workload. In some subjects exhaustion produces a decrease in C. This may represent a homeostatic defense mechanism not only to prevent total depletion of body fuels but
also to stop potential damage, physiological and psychological, to the individual.

Some authors contend that exercise 'per se' does not stimulate GC secretion unless it is accompanied by emotional stress (Angeli et al., 1977; Raymond et al., 1972). The reality probably lies on a continuum between the two stimuli. Evidence for GC secretion in isolation comes from Hartley et al. (1972) who showed that trained athletes continue to show an increase in GC level at workloads which were not perceived to be stressful.

**Differential Effects on Cortisol and Catecholamine Patterns during Physical Exercise as a Function of Level of Fitness.** The patterns of catecholamine and cortisol secretion over time as a function of level of fitness are of particular interest when comparing the adaptation process associated with coping with psychological stress. The establishment of certain patterns and benefits of physical training, at both a physiological and hormonal level, may have a cross-adaptation effect on the mechanisms used to cope with emotional stress. The pathogenesis of coronary heart disease has been seen to be affected by physical training and its concomitant adaptations (Froehlicher & Brown, 1981; Siscovick, Weiss, Fletcher, & Lasky, 1984). The plausibility of a relationship existing between physical fitness and coping is implicated in the reduction of CHD incidence as psychological stress is one of the more prevalent factors in its aetiology. The development of a rationale may be clarified by exploring the differences that exist between the trained and the non-trained in response to physical activity.
The anticipatory reactions to exercise are relevant here prior to discussing the patterns on commencement of exercise itself. The problems associated with plasma sampling in a study by Mason et al. (1973) on the anticipation of exercise and the plasma C and NE responses are outlined. More often than not the baseline measure recorded in a 'pre-post' design will be affected by a number of confounding variables that will distort the interpretation of hormonal patterns over time (Mason, 1968). Two groups were examined for anticipatory reactions to physical exercise. One group performed at 40% of VO2 max and the other at 70% of VO2 max. Twenty minutes prior to the first trial involving exercise to exhaustion for both groups at their respective levels there were significant plasma C and NE rises. Mason et al. (1973) stated that these responses appeared to reflect anticipatory reactions before strenuous exercise. In successive trials changes were not significant suggesting coping or adaptation took place as the situation lost its aspect of novelty. These findings are supported by Curtis, Nesse, Buxton, and Lippman (1978), who showed similar results over a series of trials in flooding experiments. Anticipatory variables should be examined in the interpretation of the data and the reasons for hormonal variations ascertained.

The patterns of catecholamine secretion and disappearance in fit and unfit subjects are not entirely clear. Lehmann et al. (1981) found no training dependent differences during maximal ergometry exercise between a group of trained cyclists and a group of healthy untrained subjects. The increase in plasma catecholamines did not reach significance in the trained group until 85% O2 intake and in the
non-trained until 75% O2 intake. The cardiovascular demands were closely linked to metabolic bi-products and in this case the onset of lactate acidosis matched the O2 intake curve thus suggesting the catecholamine responses may have been due to discomfort as well as physiological demand. There were also no inter-group differences in the rate of disappearance of NE after cessation of exercise as has also been reported by Hagberg, Hickson, McLane, Ehsani, and Winder (1979).

Peronnet et al. (1981) found no differences in NE secretion in a pre-post study with a training programme at the same relative workloads. At the same absolute workload after the training period there was a reduction in NE secretion. Sympathetic nervous activity can be seen to be proportional to the workload and linked, therefore, to exercise requirements.

Winder et al. (1979) carried out a similar investigation in looking at the time course of hormonal adaptation to physical activity during a 9 week training period. The results differed from those reported above as at a similar VO2 max workload after the 9-week training period, plasma E was lower after the 90 minute session. This could reflect an adaptation effect at both a physiological and psychological level to the stress of exercising for a long period of time. No cause and effect relationship can be determined but it is possible that the hormonal and physiological adaptations influenced the emotional balance.

White, Ismail, and Bottoms (1976) examined the serum corticoteroid (SC) reaction to physical activity in an active and sedentary group and respective changes in both groups over a 4-month training programme.
The active group had significantly lower levels of SC than the sedentary group before the training programme started. The pattern of response to physical activity reflected the physiological differences between the two groups as at high intensity exercise there was a significant rise in SC's in the sedentary group with no similar rise in the active group. The training programme showed a reduction in SC levels at the same relative workloads. This can be accounted for either by a reduction in the physiological stress and/or an increase in stress tolerance. The recovery phase in the active group showed a marked drop while the SC level in the sedentary group continued rising. Both these patterns are interesting for their possible interpretation as reflecting coping behaviour when exposed to a purely psychological stress.

Hartley et al. (1972) found no training dependent changes in cortisol (C) during prolonged exercise. They did however find a lower level of NE after a training effect. This reflects a decrease in the rate of glycogen utilisation and hence a conservation of fuel stores enabling improved performance.

Bloom et al. (1976) compared two groups of cyclists, one fit and one unfit, and concluded that plasma C fell at low and moderate exercise rates in both groups but to a smaller extent in the unfit group. Cortisol values rose at higher workloads and were significantly higher in the unfit group at the end of the exercise. Plasma catecholamines rose in both groups during exercise but the rise was significantly less in the fit group.

In spite of some differences in the literature, due largely to
varying methodologies, some patterns do emerge as regards the reactivity of C and catecholamines to physical exercise in trained and untrained individuals. At the same relative workloads there are lower levels of NE, E and C in the trained. In addition the increase of catecholamine levels occurs later in the trained than the untrained. There is also a quicker return to baseline of C after cessation of exercise in the trained. These differences support the thesis that trained individuals possess the potential to react to psychological stressors with a reduced endocrinological output and a faster return to baseline as compared to the untrained.

**Physical Fitness and Reactivity to Psychological Stress.** Several studies have recently looked at the reactivity to psychological stressors in groups of varying levels of physical fitness (Dienstbier et al., 1981; Hollander & Seraganian, 1984; Hull et al., 1984; Keller & Seraganian, 1984; Schwartz, 1981; Sinyor et al., 1983). All the studies were designed to examine the implicit relationship between the responses of trained and untrained individuals to psychological stressors as measured by selected psychological, physiological, and endocrinological variables.

Sinyor et al. (1983) based their rationale for different responses between the trained and untrained on the parallel response to physical and psychological stressors and hypothesised a more rapid return to baseline in the trained after exposure to various psychological stressors. Dienstbier et al. (1981) and Dimsdale and Moss (1980) also used this rationale in studies of similar design. Sinyor et al. (1983) used 15 fit and 15 unfit male subjects with a mean age of 26. Each
subject was exposed to three psychosocial stressor tasks - mental arithmetic with white noise, the ECG quiz, Stroop colour-word. The following measures were used to assess the response: heart rate, plasma E and NE, C, prolactin, lactic acid and anxiety self-ratings. Multiple sampling points were used to look at the response over time intervals of 15 minutes for baseline, 17 minutes for the stressor tasks, and 15 minutes for recovery. Results showed that the fit group returned to baseline more quickly on heart rate, had less anxiety at the end of the stress session, and peaked earlier on NE scores and were therefore returning to baseline while the untrained scores were continuing to rise. There were no performance differences between groups so the tasks were equally difficult across all subjects. These data lend some support to the hypothesis of a more rapid return to baseline but the study had some design faults which might have confounded the results. The baseline measurement, although not intended to be a truly basal recording, took place only 15 minutes after insertion of a 19G butterfly catheter and also immediately prior to the start of the stressor tasks. The anticipation effects of the tasks and the act of venipuncture could well have caused a significant reaction and thus confounded the results (Mason et al., 1973). The use of laboratory stressor tasks may also have restricted the degree of response and thus limited potential between-group differences. Furthermore, the statistical analysis was questionable as single ANOVA's were used for each dependent variable rather than using MANOVA's.

Hull et al. (1984) carried out a study to examine the responses of trained and untrained subjects to active and passive stressors. The
stressors were undertaken in series: (a) Passive psychological-industrial accident film, (b) Active psychological-Stroop task, (c) Passive psychological-cold pressor, (d) Active physical-treadmill run to exhaustion. Reaction was measured using heart rate, blood pressure, plasma NE and E, and subjective anxiety ratings. The results showed that all stressors elevated the measures significantly. The only fitness related difference was in the 9th minute of the treadmill run where the fit group had significantly lower NE scores than the unfit group and at exhaustion where the fit group had significantly higher NE scores than the unfit group. The findings were limited as the study had several design faults. Aerobic fitness was defined as the length of time each subject could run on the treadmill until feeling exhausted. Although it was reported that all but 4 subjects achieved a heart rate of 90% of their theoretical maximum this does not appear to be a very reliable method of assessing fitness in view of the fact that there are several tests, direct or indirect, available that are known to be valid and reliable measures of aerobic power. There was a large variation in the age of the subjects. The least fit group had a mean age of 40.8 while the fittest group had a mean age of 29.5. This variation could have confounded the manner in which the stressors were perceived and hence the response. In addition, the fittest group contained 8 males and 1 female, and the least fit group 7 males and 9 females. Where fitness differences were obtained in the results, gender effects were analysed in an attempt to control for this skewed distribution. Finally, the stressors were carried out in series and thus the accumulative effect of each stressor would likely
be considerable and render attempts to draw out differences between active and passive stressors difficult.

Schwartz (1981) used the homeostasis and recovery concepts as a definition of coping to look at differences between physically trained and untrained males in response to psychological stressors. Heart rate, SCR frequency, E, and subjective anxiety were used to measure the response. The trained group had a faster post-stress physiological recovery (heart rate and SCR) but there were no psychological differences. Although the E scores showed a faster recovery rate in the fitter group the analysis was not reliable as there were only 2 subjects in each group due to lost samples.

Overall there appears to be some evidence supporting the hypothesis that trained individuals, through a process of cross-adaptation from physical to psychological stressors, are able to cope more efficiently with psychological stressors. Simultaneous, multimodal sampling over a period of time is necessary to accurately assess the stress response and to relate the psychological and physiological reactivity. Further research is needed to highlight the different responses of the trained and untrained to psychological stressors, and to gain a deeper insight into the processes that are responsible for the differences.
Type A Behaviour and Control

Type A Behaviour Pattern originated from research carried out in the 1950's by two physicians involved with coronary heart disease patients. Theories such as diet, lack of exercise and high blood pressure did not appear to be making headway in the drive to reduce CHD incidence so the physicians started to look at other behaviour patterns. The behaviour patterns of coronary prone patients all had some common elements which were identified and named Type A Behaviour Pattern (TABP). Friedman and Rosenman (1974) defined TABP thus: "An action-emotion complex that can be described in any person who is aggressively involved in a chronic, incessant struggle to achieve more and more in less and less time, and if required to do so, against the opposing efforts of other things or other persons" (p.84). They regard the TABP as a trait characteristic which requires a specific external stimulus for its initiation.

The TABP has since generated a large amount of research and a sizeable knowledge base (Matthews, 1982). In spite of the moderate success of the behaviour pattern to predict CHD (Rosenman et al., 1975); there still remains considerable variance among the instruments purporting to assess TABP (Bass, 1984; Matthews, 1982). The three major tools in use in North America, the Structured Interview (SI) (Rosenman et al., 1975), the Jenkins Activity Survey (JAS) (Jenkins, Rosenman, & Zyanski, 1974), and the Framingham Type A scale (FAS) (Haynes, Feinleib, & Kannel, 1980), have only the slightest overlap and can be considered to be measuring different aspects of the TABP (Bass, 1984; Byrne, Rosenman, Schiller, & Chesney, 1985; Matthews, 1982). However,
Bass (1984) concluded that the TABP was still worth taking into consideration as many of the other intervention programmes focusing on traditional causes of CHD, such as diet, cholesterol and cigarette smoking, had proved only partly successful.

**TABP as a Coping Style.** The use of the TABP categorisation has its origins and central applications in the early identification and prevention of coronary prone behaviour. Because one of the pathogens of CHD is believed to be psychological stress and its interaction with TABP, the behaviour pattern has also been studied as a coping style in the face of stressful stimuli (Glass, 1977; Pittner et al., 1983; Vickers et al., 1981). Lazarus and Folkman (1984) listed several coping styles and mechanisms which have essentially grown out of the ego psychological literature. They also identified TABP as a coping style, and noted that it was different from other styles in that it was based on behaviour rather than ego processes. Furthermore they regard TABP as having a general effect on health through psychosomatic processes rather than the cardiovascular effects on atherosclerosis in isolation. Therefore their interest in the TABP is extended beyond a single predictor variable of CHD to an index of behaviour which may elicit psychosomatic illness through poor adjustment to psychological stressors.

From the original definition TABP is only stimulated by the appropriate environmental challenge and is therefore a type of trait characteristic. However, these challenges, whether self-imposed, or naturally occurring, must either create a reaction of sufficient intensity and/or occur frequently enough to result in the long-term
TABP activity necessary to produce psychosomatic illness. Therefore, Lazarus and Folkman (1984) postulate that TABP is a relatively stable personality dimension which may be considered an enduring coping style.

Much of the evidence for differences between Type A and Type B individuals stems from their different psychobiological reactions to stressors (Frankenhauser, 1983; Frankenhauser, Lundberg, & Forsman, 1980; Henry & Stephens, 1977; Jennings, 1984). This is not unreasonable as the major concern focuses on pathogens of psychosomatic illness and these include: blood pressure, heart rate, and catecholamines. The initial categorisation of TABP usually comes from the assessment of an individual's activity pattern through one of the three major tools: SI, JAS, FAS. Therefore, having established a certain behaviour pattern and linked it closely to significant differences in psychobiological reactions to stressors, it is necessary to draw out the psychological correlates of the behavioural and physiological indices in order to obtain a more definable measure of the individual's coping style.

The attempt to link psychological and physiological indices of the TABP has received a certain amount of attention and has produced evidence which suggests that a number of trends exist that constitute styles of coping (Chesney, Black, Chadwick, & Rosenman, 1981; Glass, 1977; Matthews, 1982; Pittner & Houston, 1980; Pittner et al., 1983; Rhodewaldt & Davison, 1983; Vickers et al., 1981). One of the earliest, and arguably most influential, links between TABP and coping is the construct of control. Glass (1977) has developed this relationship and it has since been a pervasive element in many studies of CHD and
psychological stress (Contrada et al., 1982; Matthews, 1982; Pittner et al., 1983; van Schijndel, de Mey, & Naering, 1984).

Glass (1977) predicts that Type A's become hyper-responsive in uncontrollable situations in an attempt to achieve control. Even in relatively neutral situations Glass believes that Type A's are preoccupied with the desire to control. This brings into light the possibility that TABP, in conjunction with lack of control, is itself an indicant of poor coping.

Pittner et al. (1983) looked at the responses of Type A's and B's to consistent, intermittent and lack of control conditions. Anxiety and hostility scales from the Multiple Affect Adjective Check List (Zuckerman & Lubin, 1965) and subjective reports of distress were used as the measures of affect during the trials. Blood pressure and heart rate were taken as physiological measures and the Thurstone Activity Scale (Thurstone, 1949) as the Type A/B predictor. Finally, cognitive coping strategies were measured by structured interviews and judgements as to type of cognitive behaviour. It was found that Type A individuals used different coping strategies and these were marked with the use of more denial and projection. This form of avoidance demonstrates that Type A's may expose themselves more frequently and for longer periods of time to stressors than do Type B's and hence the negative effects on their health.

Vickers et al. (1981) carried out a component analysis of the JAS TABP questionnaire and correlated the components as well as the overall Type A/B score with a battery of coping and defense measures. JAS subscale 'Job Involvement' was found to be associated with higher
scores for coping mechanisms and JAS subscale 'Speed and Impatience' with higher scores for defense measures. Also JAS subscale 'Hostility' was associated with lower coping skills. Despite the patterns reported in previous literature they did not find a relationship between TABP and defense mechanisms. The results do not show a generalised tendency for TABP individuals to be unable to adjust to stress but Wickers et al. (1981) suggested that a deficient adjustable capacity may only occur when a Type A individual is exposed to conditions that activate that behaviour pattern. This concurs with the original definition of TABP by Friedman and Rosenman (1974) and also with the process-oriented definition of coping in this study.

TABP, in certain conditions, can be associated with poor coping skills. Therefore, in order to establish the coping skills that a Type A may be employing, it is important to assess other qualitative measures that are known to affect the cognitive framework of that individual. In this way a more accurate description of the Type A's coping mechanism may be made in addition to factors already known about the behaviour pattern itself.

**Effects of Physical Fitness.** This section reviews the specific effect physical training has on the TABP and its link to possible improvements in coping behaviour through changes of those behaviour patterns 'per se' rather than through the physiological or hormonal patterns.

There has been much research done on CHD patients (e.g., Froehlicher & Brown, 1981) but little on a healthy population to alter the TABP and perhaps prevent the onset of ill-health. Blumenthal et
al., (1980) studied the effects of a 10-week training programme on a group of 46 healthy, middle-aged adults. The pre-post design looked at the component variables of the JAS A/B classification: speed/impatience, job involvement and hard driving as well as the overall A/B score. Physiological measures of blood pressure, serum lipids, body weight, plasminogen activator release and treadmill performance were also taken. There was a general physiological improvement for both groups after the 10-week training programme. Overall scores on the Type A/B scale reduced significantly for Type A's but not for Type B's. The component factors had small and non-significant reductions for both groups of subjects. There was a significant reduction in the coronary risk profiles of all exercising subjects.

These data support the hypothesis that physical training would reduce the risk profile of Type A's and also alter the TABP itself. It is the first study of its kind to actually note that the behaviour pattern itself changed as a consequence of increased exercise. To what extent the change was a function of the psychological feelings attached to doing regular exercise or of the increased cardiovascular and endocrinological efficiency cannot be determined as the study lacked a control group. It is possible that in specific TABP eliciting conditions cardiovascular and physiological profile mechanisms, due to their changes, might alter the threshold of the onset of the characteristic reactions of a Type A individual.

Lake, Suarez, Schneidermann, and Tocci (1985) examined the physiological reactivity of Type A and B fit and unfit individuals to
various psychological stressors. They hypothesised that sedentary Type A individuals would show the greatest reactivity to the stressors and that overall, Type A's would show greater reactivity than Type B's. Seventy-three normotensive male students (18-24 years) were split into fit and unfit groups through self-report and an indirect VO2 max step test. Each subject was classified as Type A or B using the SI and was then exposed to four stressor tasks: snake handling, cold pressor, competitive card game, and mental arithmetic. The SI itself was also used as a stressor task. Reactivity was measured by systolic and diastolic blood pressure, mean arterial blood pressure and heart rate. Sedentary Type A's displayed the greatest reactivity on all measures during the SI itself. However, in the competitive card game situation the fit Type A's reacted with significantly greater systolic blood pressure than Type B's or sedentary Type A's. Also the fit subjects reacted with significantly greater increases in blood pressure than sedentary subjects while the reverse held true for reactivity during the SI.

The hypothesis for the study was only supported by the data from the SI. The paradoxical results from the card game might be attributed to the fact that all the fit subjects were actively competitive varsity athletes and were therefore reacting with a learned response to increase arousal levels in exacting situations. This type of subject sample may have unique reactions to such stressors and therefore limit the generalisability of the study. Statistically some of the methods used were questionable as all analyses were carried out on delta scores (difference from baseline) and follow-ups to the MANOVA's were done
with t-tests.

The evidence from these studies does not lead to a conclusion that those who are fitter will display less pronounced Type A characteristics. However, it does enable one to say that there exists some form of interaction between TABP and physical exercise and, although the exact mechanism has not yet been identified, certain changes occur which moderate the reaction of a Type A individual to an aversive event through physiological and behavioural differences.

**Psychophysiological Patterns.** There has been a certain amount of support for the hypothesis that Type A's respond with greater sympathetic reactivity than Type B's (Gastorf, 1981; Glass, 1977). Certain patterns have emerged regarding the reactivity that suggest Type A's have a less efficient adaptive system in face of stressors than Type B's. Frankenhauser et al. (1980) compared the reaction patterns in healthy male and female students, classified as Type A or B individuals, in an achievement-oriented choice reaction task. The situation was one of high controllability and was used in order to compare reactions to conditions where lack of control is predominant. It was found that Type A performed significantly better than Type B and as the situation was not considered to be one of high challenge, the physiological and psychophysiological cost was not significant. An interesting aspect of the study was the dissociation of the sympathetic- and pituitary-adrenal activity in response to achievement demands and controllable situations respectively. The sympathetic-adrenal response was activated as the task demands increased and the pituitary-adrenal response was deactivated as a
consequence of the highly controllable situation. This pattern is supported by Henry and Stephens (1977) who, in their review of neuroendocrine responses to social interaction, hypothesised that an overall reactivity pattern involving an increase of sympathetic activation during general arousal, increased E, and, that during irritated fight situations, NE increased. An increase of activity of corticotropin-producing hypothalamic cells was hypothesised when territory control was lost or threatened, and consequently increased C.

Von Schijndel et al. (1984) compared the cardiovascular responses of Type A and B males under varying degrees of behavioural control. An overall pattern of an inverted-U emerged for all subjects. That is, in the very high and very low control conditions (30% and 100% anagram solving potential) cardiovascular responses were lower than the moderate control condition (50% potential). No performance differences existed between A's and B's but A's exceeded B's in blood pressure elevations especially during the 50% condition when there was scope for active coping. This parallels Glass' (1977) findings of increased NE during active efforts to cope. Gastorf (1981) also reported that Type A's had significantly higher mean SBP elevation during conditions which elicited high challenge and were demanding. Type A's also had significantly higher mean SBP than Type B's during a task which in reality was easy but they were instructed, and confirmed by self-report, that it was difficult. These results lend weight to the hypothesis that Type A's have a predisposition to achieve control even when conditions are not threatening.
Contrada et al. (1982) also compared the response of Type A and B males under differing conditions of control over an aversive event. Blood pressure, heart rate, plasma catecholamines and behavioural measures were taken during a Reaction Time task with varying levels of loud noise and/or electric shocks. Results indicated that on behavioural measures Type A's were hyper-responsive when aversive stimulation was contingent on their ability to perform well and thus impinged on their sense of control. Type A's also displayed increased plasma NE in contingency vs no-contingency trials (i.e., when confronted by uncontrollable threat). This pattern is in keeping with the hypothesis of Frankenhauser et al. (1980) and Henry and Stephens (1977). The elevated circulation of catecholamines was accompanied by an increase in blood pressure thus reflecting a general increase in sympathetic nervous activity.

Myrtek and Greenlee (1984) reviewed the literature on the psychophysiology of the TABP and found only minimal support for the theory that Type A's have an increased reactivity to stressors than Type B's. They also conducted their own study using 58 physical education students (mean age 23.3 years and mean maximal oxygen uptake of 3.8 L/min). They were classified as Type A using the SI and JAS and were then exposed to seven experimental conditions including relaxation, and passive and active stressors. A large battery of physiological and psychological measures were used to assess reactivity. Neither the laboratory or the field conditions resulted in any significant difference in sympathetic reactivity between Type A's and Type B's. However, there was no indication of the fitness levels of
the Type A and B groups and no reports on how fitness was assessed other than stating the mean maximal oxygen uptake of the sample. The suitability of a group of physical education students serving as the sample for such a study is questionable and even more so when no fitness data are made available. The authors argued that physical education students do not differ from other students apart from having greater levels of physical fitness. This factor may have a significant effect on the physiological reactivity to various stressors.

In summary, there does appear to be evidence that supports the theory that Type A's, when exposed to aversive stimulation, appear to have a greater overall sympathetic reactivity than Type B's. This reactivity is often increased when the aversive conditions are marked by feelings of uncontrollability. However, it is possible that the physiological reactivity and/or the TABP characteristics themselves are reduced by high levels of aerobic power.
Summary

Evidence has been presented supporting the hypothesis that high levels of aerobic power enhance physiological and psychological coping efficiency in response to psychological stressors. A rapid return to baseline levels of selected psychological, physiological, and endocrinological variables was put forward as being an index of efficient coping. Cannon's (1939) homeostasis theory formed the basis of the rationale supporting the link between recovery rates and coping efficiency. In line with established exercise physiology data, that certain bodily functions return to baseline more quickly in fitter individuals after strenuous activity, it was suggested that, through a process of habituation and/or cross-adaptation, reactivity elicited by psychological stressors might respond in a parallel manner. Furthermore, the Type A Behaviour Pattern was associated with poor coping ability which could be improved by increasing levels of aerobic power. This would either alter the Type A characteristics themselves or have a direct effect on reducing the heightened reactivity to psychological stressors typical in the Type A individual.
Appendix B

Description of Measures

Jenkins Activity Survey - Form C

The Jenkins Activity Survey - Form C (JAS) (Jenkins, Zyanski, & Rosenman, 1979) is a 52 item questionnaire designed to predict level of vulnerability to coronary heart disease (CHD) due to psychosocial factors. It contains four factors: Type A/B, speed and impatience, job involvement, and hard-driving. Only 21 of the 52 questions categorise Type A/B which is of prime interest to this study.

The JAS was validated from data gathered during the Western Collaborative Group Study in 1965. Jenkins, Rosenman, and Friedman (1967) reported that there was 72% agreement between the JAS and the Structured Interview, recognised as the strongest predictor of CHD (Byrne et al., 1985), on Type A/B classification. However, Jenkins et al. (1967) acknowledged that the ultimate criterion of validity should be the emergence of CHD itself in a previously symptom free individual. Therefore a 4 year follow-up for CHD incidence among Type A's was carried out. The Type A/B scale was completed by 2750 males in 1965 and it was found that high scorers on the Type A scale had twice the incidence of CHD than low scorers over the 4 year period (Jenkins, Rosenman, & Zyanski, 1974).

Test re-test reliability coefficients between initial administration in 1965 and subsequent administrations in 1966 and 1969 ranged from 0.64 to 0.74 on Type A/B classification (Jenkins et al., 1974).
Subjective Anxiety Checklist

The checklist consists of 8 paired items on a 1 to 5 scale relating to levels of arousal (Hull et al., 1984). The paired items are as follows: (1) Relaxed - Aroused, (2) Sluggish - Energetic, (3) Depressed - Elated, (4) Calm - Anxious, (5) Fearless - Fearful, (6) Agreeable - Angry, (7) Refreshed - Fatigued, (8) Clear-headed - Confused. The checklist was employed in a study looking at responses to stressors and was used to examine subjective feelings of arousal at various time intervals. No detailed reliability or validity data were presented, although results were plotted for each paired item on bar charts as group means and these might provide validity on replication (Hull et al., 1983).

In order to establish the degree to which the items measured the same construct an internal consistency analysis was run on the data from this study (n =19). The following reliability coefficients were obtained:

- Baseline .4358
- Pre .7095
- Post .7014
- Rest 1 .5221
- Rest 2 .5058.

On examining the correlation coefficients for each paired item it was found that Item 2 'Sluggish - Energetic' had consistent negative or low total values over time while the other 7 paired items had relatively high positive coefficients. Therefore this item was reverse scored and a further internal consistency analysis was run. The following
reliability coefficients were obtained:
Baseline .5570
Pre .7517
Post .6633
Rest 1 .7652
Rest 2 .7025.

These values are all higher than the initial correlation except on the 'Post' time interval thus supporting the reverse scoring of Item 2. The moderate coefficient value for Baseline can be expected due to the relative lack of control (e.g., differing moods) in this session compared to the Rappell session when each subject underwent exactly the same stressor task. The remaining coefficients are moderately high and can therefore be said to be measuring the same construct.

Each Item score was summed for analysis and a composite value for arousal obtained.

Control

A manipulation check was carried out on each subject's level of perceived control regarding the rappell. Immediately prior to and following the rappell the subject was instructed to complete a visual analogue control scale:

<table>
<thead>
<tr>
<th>No Control</th>
<th>In Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>At All</td>
<td>(100 mm)</td>
</tr>
</tbody>
</table>

'Mark with a perpendicular line the extent to which you feel in control
about doing the rappell'.

This is a modification of a 5-point Likert scale (0 = not at all, 4 = a great deal) used by Folkman and Lazarus (1985) to examine control. Bond and Lader (1975) listed several advantages of using a visual analogue scale rather than a more conventional scale. These included ease of completion and comprehension, and choice flexibility rather than being limited by finite quantities. Joyce (1968) reported that such scales were especially sensitive when being used to monitor the time-effect curves of certain drugs.

The scale was scored by measuring the distance to the mark from the left hand side of the line, and comparison was then made between the 'pre' and 'post' administrations for the two sets of groups.

Heart Rate

The 'Heart Rate Microcomputer Sport Tester PE 2000' (Polar Electro, Finland) was used to monitor heart rate for all sessions. This consists of a transmitter and receiver so that the electrocardiographic (ECG) signal is recorded by telemetry. The transmitter is attached to a rubber electrode belt which is secured around the chest. The Sport Tester Microcomputer, which takes the form of a large wrist watch, is then attached to the wrist. Skin contact activates the transmitter which transduces the ECG signal into an electric field. This signal is recognised by the Sport Tester with its receiver circuit and an average heart rate value is computed and displayed every 5 seconds.

The Sport Tester has been developed at one of Finland's main universities with the support of the Finnish Olympic Committee and the
Finnish Academy. No validity or reliability data are given but it is reported to be as accurate as a regular 3 lead electrocardiogram (Polar Electro, Finland).

Aerobic Power

The VO2 max treadmill protocol (Rhodes & McKenzie, 1984) is a continuous, progressive loading protocol maintaining a constant elevation with increasing velocity. This type of protocol is recommended and accepted as a valid and reliable measure of VO2 max (Thoden et al., 1983). The on-line data collection consists of an automated metabolic measurement cart and an electrocardiograph interfaced with a high speed data acquisition system controlled by a desk top computer. This system has been shown to be valid and reliable when being used for physical stress tests such as the VO2 max (Rhodes, Wiley, & Dunwoody, 1981).
Appendix C

Assay Protocols

Catecholamines

A modification of method II of Davis, Kissinger, and Shoup (1981) is now in use to monitor plasma concentration levels of noradrenaline, adrenaline, and dopamine. In this procedure plasma (1-3 ml) is mixed with alumina in the presence of a basic buffer and an internal standard, and the catecholamines are eluted from the separated alumina with dilute perchloric acid. The filtered perchloric acid solution is injected into a liquid chromatograph fitted with an electrochemical detector. The three endogenous amines (and the internal standard) are oxidised at the glassy carbon electrode of the detector to give a current change which is directly proportional to the concentrations of the analyte in the effluent from the LC column. At a signal:noise ratio of 2:1 the minimum detectable quantity of dopamine (the least sensitively detected CA) in the system now being used is about $3 \times 10^{-8}$ g.

Cortisol

A radioimmunoassay kit (GammaCoat, Travenol-Genentech Diagnostics) was used to determine plasma concentration levels of cortisol. The procedure is based on the competitive binding principles of radioimmunoassay (Yalow & Berson, 1971). Standards and unknown plasma samples are incubated with cortisol tracer in antibody-coated tubes where the antibody is immobilized onto the lower wall of the tube. After incubation, the contents of the tube are aspirated or decanted
and the tube is counted. A standard curve is prepared with 5 serum standards ranging from 2 to 60 ug/dl. Unknown values are interpolated from the standard curve.