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Articles

Physiological Stress Response of the Neuroendocrine System During Outdoor Adventure Tasks

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Outdoor adventure tasks involve a composite stress of both physical and psychosocial demands. Such compound stressors are not often studied, yet this is the type of stress most often associated with active leisure experiences. The purpose of this study was to describe urinary epinephrine, norepinephrine, and cortisol responses to various outdoor adventure tasks, and to evaluate the influence of aerobic fitness on these responses. Adult participants were recruited from individuals who had voluntarily registered and paid for a nine-day outdoor adventure program. Urine samples were collected from 15 participants following the tasks: beginning and advanced rock climbing, beginning and advanced whitewater canoeing, ropes course, and backpacking, as well as pre and post-course van rides. The advanced rock climbing and advanced whitewater canoeing days elicited the highest urinary neuroendocrine responses, and lower fit participants had higher neuroendocrine levels when compared to the higher fit participants.

KEYWORDS: *Epinephrine, norepinephrine, cortisol, adventure, stress*

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Introduction

Outdoor adventure programs have a growing clientele of middle aged professionals. Programs that traditionally have been thought of as youth oriented, because of their intense physical and psychological challenges, have moved into corporate America (Froiland, 1994). Outdoor adventure's typically unfamiliar challenges include coping with risks in the social, psychological, and physical realms. Although such challenges are usually perceived as stressful, the experience of performing adequately outside of one's comfort zone (under stress) can stimulate a wholistic type of growth. It is this growth that individuals and corporations are seeking because of the need to perform in the midst of challenges and risks in today's world. To adapt or condition ourselves for life's stressors, it is possible that some individuals are attracted to recreational pursuits that also present multiple types of challenges and risks (meta-challenge).

Folkman and Lazarus (1985) have defined stress as a "relationship between the person and the environment that is appraised by the person as relevant to his or her well-being and in which the person's resources are taxed or exceeded" (p. 152). Two of the components of stress discussed by Folkman and Lazarus are hallmarks of outdoor adventure. One component is *challenge,* defined as "potential for growth", and another is *threat,* defined as "potential for harm or loss" (p. 152). Outdoor adventure programs entail both components of stress, yet are reportedly beneficial for developing positive qualities such as self-awareness, self-confidence, communication skills, and problem-solving skills (Ewert, 1989; Laurence and Stuart, 1990). Since the development of such qualities is an objective of most outdoor adventure programs, research regarding such programs has focused on affective issues. However, it is also important to document the physiological responses associated with the unique stress of outdoor adventure.

One of outdoor adventure's foundational theories is that of optimal arousal (Ewert, 1989). This theory was developed primarily by Elizabeth Duffy over a 30 year period (Duffy, 1957), and refers to the degree of activation/stimulus/challenge that elicits the greatest quality of performance/benefits. Its application in the outdoor adventure context is that an "appropriate" degree of challenge enables or facilitates efficacious growth. This general idea has been supported through a variety of affective studies, but identifying an optimal arousal point relative to the neuroendocrine system remains a distant possibility. In their review of psychophysiological indicators of leisure benefits, Ulrich, Dimberg, and Driver (1991) state that in addition to physiological research that is needed for passive leisure experiences, "Research is also needed on the short-term or immediate psychophysiological consequences of *active* leisure experiences" (p. 85).

Outdoor adventure provides a different stress model from that typically studied. Controlled laboratory stress research generally focuses on: (a) *physical* challenges such as maximal or submaximal physical exertion via bicycle ergometer or treadmill, (b) *psychological* stress via the STROOP color test, an aversive film, mental arithmetic, etc., or (c) *psychosocial* challenges that add a monitoring video camera or live evaluators to watch while the psychological tasks are attempted. Field-based or naturalistic stress research has most often utilized typical workdays of various professions and public speaking (Pollack & Steklis, 1986; Bolm-Audorff, et al., 1989; Al'Absi, et al., 1997). On a few occasions, field-based physical challenges have been studied, such as rappelling and rock climbing (Brooke & Long, 1987; Bunting, et al., 1986). However, in these studies the challenges have been conducted for the purpose of the research study rather than in the context of a naturally occurring program.

The stressors in outdoor adventure programs are distinct from those previously investigated. Not only do the challenge tasks involve varying degrees of physical exertion, but they are simultaneously psychosocially demanding. For example, it would be a significant psychosocial challenge to maneuver your way solo-paddling through a whitewater rapid while your peers and leaders watched, but to tandem-paddle through a rapid while sharing a boat with a partner adds another dimension to the challenge. There are "real" risks or threats (potential for harm or loss) involved that are perceived by each individual to be at a different point on a "degree-of-risk" continuum. Threats could be anything from physical danger to a psychosocial danger of the loss of respect. Outdoor adventure programs are typically organized into small groups of nine to 12 participants per group. Therefore, a multiday experience includes almost constant interpersonal interactions, and the evolving sense of relationship. It is this "sense of relationship" and the knowledge of the group's interdependence along with the physical demands that make the challenges of an outdoor adventure program more likely to be a true combination of stresses or "meta-challenge." Although any physical exertion challenge has elements of psychological stress, unless there is the possibility of psychological and social loss, the stress is primarily that of physical exertion. This has been demonstrated by numerous researchers of physical stress reporting significant increases in norepinephrine (the catecholamine most closely aligned with physical stress), with no increase in epinephrine (most indicative of psychological stress) (Frankenhauser, 1981; Williams, 1986). Since most outdoor adventure programs are designed to provide confidence-building yet provocative physical and psychosocial challenges, they provide a distinctive stress model for study.

Most stress response investigations attempt to focus on either physical or psychological challenges, but such delineation is not possible during adventure tasks. Numerous studies have evaluated the relationship of physical fitness to the sympathetic nervous system response (epinephrine and norepinephrine) during physical exertion. It has been shown that physical stress evokes elevations of catecholamine levels, predominantly norepinephrine (NE) (Von Euler & Hellner, 1952; Frankenhaeuser, 1981). When physical fitness levels have been taken into consideration, lower fit subjects generally have had greater catecholamine responses, especially NE, to physical challenges (Brooke & Long, 1987; Sothmann, Ismail & Chodzko-Zajko, 1984).

Epinephrine (E) response during exercise has been found to be less consistent (Williams, 1986) which seems to corroborate Frankenhauser's (1981) findings of E being primarily responsive to psychological stress. However, when physical fitness is utilized as an independent classification or control variable in studies of psychosocial stress rather than physical stress, the results have been mixed for E, NE, and cortisol (CT) (Sinyor, Schwartz, Peronnet & Seraganian, 1983, 1988; Hull, Young, & Ziegler, 1984; Brooke & Long, 1987, and Claytor, Cox, Howley, Lawler, & Lawler, 1988). A meta-analysis of 34 studies that used either physical or psychosocial stress showed that aerobically fit subjects have a lower level of stress reactivity (Crews & Landers, 1987). More recently, some research appears to indicate an augmented (increased) E and NE response to stress in highly trained individuals (Kjaer, 1992) and a more rapid recovery from an acute stressor (Sothmann, et al., 1996).

Most investigations of sympathetic nervous system response have used laboratory stressors that involve either physical exercise or sedentary psychosocial challenges, i.e. the STROOP test, mental arithmetic, etc (Sothmann, et al., 1988; Blumenthal, et al., 1990; Claytor & Cox, 1992). Although such control is desirable when investigating specific types of stress, such was not the intent of this study. A combination of physical and psychological stress in naturalistic situations was the focus of this investigation. The field situations used were, in fact, situations that a growing number of adults are seeking (Ewert, 1989). Therefore, the purpose of this study was to describe selected neuroendocrine responses to various adventure tasks, and to determine if individuals who differ in estimated aerobic fitness have different neuroendocrine response profiles for the investigated tasks.

Method

Participants

Subjects were recruited from individuals who had voluntarily registered and paid for a nine-day outdoor adventure experience for adults with a well recognized adventure education organization in the southeast United States. Volunteers were screened for centrally acting medications which could influence neuroendocrine response, i.e. steroids, beta-blockers, antihistamines, etc. Following medication screening, 35 volunteers were mailed additional information prior to their course start date and asked to comply with dietary restrictions beginning 24 hours prior to their arrival. Caffeine, chocolate, and tobacco were restricted from use. Four volunteers were disqualified due to their failure to comply with the dietary restrictions. The 31 remaining subjects included 17 males and 14 females. Out of the 31 subjects, only 15 had complete data for all collection periods. Therefore, the data analysis and discussion for this investigation are based only on the subjects with full data sets. Of the 15 subjects used in the analyses, 10 were classified as higher fit and 5 were lower fit. The gender make-up of the higher fit group was three females and seven males. In the lower fit group, the gender composition was four females and one male. The age range of the 15 subjects was 22 to 49 years. The analyzed data was not fractionated by gender and age because of the small cell sizes associated with such subdivision. Thus, any dependent variable variation attributable to age, gender and their interaction is housed in the error term.

Participants from three spring-time courses constituted the 15 person subject pool. Each course was very similar in design and substance. Each course was nine days in duration, all conducted by the same organization, in the same location, with the same tasks. Although it was not possible to insure that each subject's experience was 100% the same as other subjects due to different instructors, differing weather conditions, etc., other factors were controlled that have not been controlled in previous field studies. For example, all participants ate the same diet which was free from caffeine and chocolate; participated in the same type and amount of physical activity; and got approximately the same amount of rest.

Measures

Aerobic Fitness

It was important to have a mechanism for assessing aerobic fitness immediately prior to the adventure program that would not have an impact on the adventure stress responses. Therefore, an estimate of aerobic fitness was obtained via the University of Houston Non-Exercise (N-Ex) Test. This instrument is used to estimate aerobic fitness levels from one of two models (Jackson, Blair, Mahar, Wier, Ross & Stutevill, 1990). The model selected for this study utilized information regarding gender, age, a code for self-reported exercise habits, and estimates of percent body fat from skinfold measurements. The N-Ex Test has a validity coefficient of $r = .81$ with maximal oxygen uptake (VO_2 max) from 2,009 subjects and has been found more accurate than estimates from the Åstrand (1960) prediction models. Due to the high correlation to VO2 max, the ease of administering in a field setting, and no requirement for any physical exertion extraneous to the actual adventure course, the N-Ex Test was well suited for this investigation.

Urinary Catecholamines (CA)

To examine response to situational stress with a duration longer than several minutes, urinary assays are preferred to plasma (Akerstedt, Gilberg, Hjemdahi, Sigurdson, Gustavsson, Daleskog, and Pollare, 1983; Frankenhaeuser, 1981; Steptoe, 1987). Since each data collection period for this study was three to five hours in length, urinary assays were the most appropriate. Prior to each data collection period, subjects were instructed to empty their bladders and told that any urine voided during the measurement period must be collected in containers supplied by the researcher. At the end of each measurement period, urine was collected from each subject and the volume measured. A 25 ml sample was taken for each subject at each collection period, transported in cold storage to a freezer within one hour of collection, and stored at −35°C. Samples were shipped frozen in dry ice to the Duke Medical School Pharmacology Laboratory for analysis. Levels of norepinephrine and epinephrine were measured by high-pressure liquid chromatography (HPLC) with electrochemical detection (Kilts, Gooch & Knopes, 1984). This assay had an intra- and interassay coefficient of variation for norepinephrine of <9% and for epinephrine <10%. Urine cortisol levels were measured directly by simple radioimmunoassay using HPLC-purified ^{3}H-Cortisol from New England Nuclear (Wilmington, DE) and antiserum and standards from ICN Biomedicals (Costa Mesa, CA). The intra- and interassay coefficient of variation for cortisol was <7%. Epinephrine, norepinephrine and cortisol were standardized to creatinine excretion to adjust for time variations between collection periods. Urine creatinines were measured using the Jaffe method as modified by Slot (1965).

Procedure

Upon arrival at the initial meeting site (airport), the study was further explained and subjects gave informed consent. After arriving at the program site, the first urine sample was collected. Aerobic fitness estimates were then completed prior to beginning any adventure tasks. Subsequent urine collections were made daily following a three to five hour adventure task period, with time of day corresponding closely for all collections. Each three to five hour data collection period began with all participants emptying their bladders.

Tasks

Van Rides

The first data collection period was at the conclusion of the three hour van ride (Task 1) from the airport (the initial gathering location) to the program site. This time period and the van ride returning to the airport at the end of the course (Task 8) were used as non-challenge periods to be analyzed along with the adventure task data collection periods. Although there was very little physical exertion during the van ride periods, and the time of day corresponded to the adventure task periods, neuroendocrine values for these two collection periods cannot be considered true baseline measurements.

Adventure Tasks

On the basis of a survey of previous adventure program participants, four tasks were identified by participants as "highly challenging." These adventure tasks, which were three to five hours in duration, were designated as the challenge measurement periods. The tasks were: wilderness backpacking (Task 2); rock climbing and rappelling, an introductory day (Task 3) and an advanced day (Task 4); ropes course events (Task 5); and whitewater canoeing, an introductory day (Task 6) and an advanced day (Task 7). All subjects participated in each of these tasks. The tasks were encountered on consecutive days, but were not presented in the same order in each of the three courses.

Wilderness Backpacking (Task 2). This task involved hiking through thick vegetation both on and off trails, while carrying approximately 35% to 45% of one's body weight. The terrain consisted of steep inclines and declines as well as some relatively level ground.

Rock Climbing/Rappelling (Task 3 & Task 4). The introductory day (Task 3) was conducted at an introductory site and focused on all participants making at least two climbs and belaying for at least two other participants. There was one rappel made by all participants. The climbs were primarily friction types of climbs with ratings of approximately 5.5-5.6 according to the Yosemite Decimal System (Fyffe & Peter, 1990). This rating system ranks climbs from 5.0 up to 5.13+ that require the use of the hands. A ranking of 5.0 means the climbers' hands are used only for balance and a 5.13 ranking requires significant upper body strength, flexibility, and climbing skill. Climbs with rankings of 5.5-5.6 are generally accepted as introductory level climbs. The advanced day (Task 4) was designed to be more challenging, with steeper more difficult climbs ranging from 5.7 to 5.9 in difficulty and a steeper, longer rappel.

Ropes Course (Task 5). The ropes course consisted of an obstacle type structure that had participants start on the ground and work their way up and around a series of obstacles constructed between four 50 ft. telephone poles. The last event or exit from the obstacle series was a giant pendulum swing from a platform approximately 40 ft. high. Most of the events in the series required varying degrees of balance, strength, and agility while at ever increasing heights.

Whitewater Canoeing (Task 6 & Task 7). The first day of whitewater canoeing (Task 6) was an introductory experience to river canoeing on a section of river that had clear open channels with swiftly flowing water often producing ripples and waves. The second day experience (Task 7) was conducted on a more advanced section of the same river with many sets of waves and rapids that required negotiating the canoe in a specific route to avoid rocks and more turbulent water. In each group of participants, there were several capsizes on this day. Each subject capsized once and two subjects capsized twice.

Design

To answer the questions posed in this research, the design used was a two factor factorial with subjects being repeated across the second factor. Separate ANOVAs were used for the three dependent variables (epinephrine, norepinephrine, and cortisol) because the ratio of observations to dependent variables was too small to warrant MANOVA.

Data Analyses

The 2 (groups) × 8 (tasks) factorials with subjects being repeated across the second factor were used to evaluate main effects and interactions. An alpha level of .05 was used as the level of significance. Adjusted F probabilities (Greenhouse-Geisser and Huynh-Feldt) were obtained for the within subjects effects. The GLM procedure with the REPEAT option from SAS was used to accommodate the unequal cell sizes and the repeated measures.

Post-hoc follow-ups were achieved using the Least Square Means (LSM) procedure since the number of observations in the two fitness groups was unequal. This same procedure was used with tasks even though the observations across tasks were equal.

Results

Classifications

Estimated Fitness. The fitness estimates from the University of Houston Non-Exercise Test were translated into a percent ranking based on gender and age following the YMCA's Physical Fitness Evaluation Form (Golding, Myers & Sinning, 1982).This type of classification was necessary for standardizing VO_2 max estimates relative to gender and age. The Higher Fit Group was operationally defined as those subjects whose VO_2 max estimate placed them in the 85% or higher ranking, and the Lower Fit Group were defined as those ranking 75% or below.

Fitness and Task Effects

In each of the ANOVAs (Table 1), a significant main effect was obtained for Groups and Tasks. These results were judged to be significant even after adjustment for possible sphericity violation. The interaction effect was not significant for any of the dependent variables.

The LSM results (Table 2) for the Groups indicated that for each dependent variable, the average response of the Lower Fit Group was significantly higher than that of the Higher Fit Group.

In regard to the significant main effect for Tasks, the LSM results (Table 3) indicated comparable results for each of the dependent variables. Using an underline notation (any Tasks having a common underline are not significantly different from each other) and a numbered listing of the Tasks from Table 3, the LSM results may be summarized as follows:

Epinephrine – 8 *2 1 6 4 3* 5 7; Norepinephrine – *1 8* *3 5 2 4 6* 7;

and Cortisol – *1 2 3 8* 5 6 7 4.

Task 7 (advanced canoeing) elicited the highest responses for E and NE, and Task 4 (advanced climbing) for CT. The neuroendocrine responses to the remaining tasks were all similar.

TABLE 1
Summary F Ratios for Epinephrine, Norepinephrine and Cortisol

Source	df	F: E	F: NE	F: CT
		Between Subjects		
Groups (A)	1	17.62*	10.99**	6.76*
S within-group error	13	(286.12)	(4258.43)	(17858.48)
		Within Subjects		
Tasks (B)	7	6.50**	10.00**	3.95**
$B \times A$	7	1.40	1.23	1.12
$B \times S$ within-group error	91	(93.37)	(815.42)	(3450.11)

Note: Values enclosed in parentheses represent mean square errors. E = epinephrine; NE = norepinephrine; CT = Cortisol; S = subjects.
$*p < .05$; $**p < .01$

Discussion

The present study offers insight into neuroendocrine responses to outdoor adventure tasks and corroborates earlier investigations that have shown lower fit individuals to have greater responses to both physical and psychosocial challenges. There is a difference however, between this investigation and the ones reviewed by Crews and Landers (1987) and Sothman, et al. (1996). The stressful tasks used in this investigation were real-life challenges occurring in the context of an outdoor adventure program, not in a laboratory or a situation designed specifically for a research agenda. The nature of outdoor adventure programs requires both physical and emotional de-

TABLE 2
Least Square Means for Fitness Groups*

Variable	Higher Fit ($S_{\bar{Y}}$)	Lower Fit ($S_{\bar{Y}}$)
	$n = 10$	$n = 5$
E	14.51	23.55
	(1.89)	(2.67)
NE	73.93	115.83
	(7.30)	(14.94)
CT	155.68	222.96
	(14.94)	(21.96)

*μg/ml creatinine

TABLE 3
Least Square Means for Adventure Tasks*

	Dependent Variable		
Tasks	Epinephrine ($S_{\bar{Y}}$ = 2.64)	Epinephrine ($S_{\bar{Y}}$ = 7.82)	Cortisol ($S_{\bar{Y}}$ = 16.09)
1. Pre-Course Van Ride	15.02	54.96	149.36
2. Backpacking	14.65	100.57	163.19
3. Introductory Climbing	21.83	96.92	163.30
4. Advanced Climbing	20.55	103.35	242.32
5. Ropes Course	22.03	98.21	198.77
6. Introductory Canoeing	17.61	104.83	202.61
7. Advanced Canoeing	31.68	134.84	219.69
8. Post-Course Van Ride	8.92	65.38	175.34

*μg/ml creatinine, n = 15

mands. This study did not attempt to distinguish between these two elements of the adventure tasks, but focused on describing the responses to such meta-challenge experiences.

For each of the three dependent variables (E, NE, CT), a statistically significant difference was indicated between the higher and lower fitness groups. Although the sample size is small, the difference is clear (see Table 2). The lack of a significant interaction between groups and tasks precluded the testing of differences between groups at each task. This may be seen in Figure 1 in which the profile for lower fit subjects across Tasks is parallel and higher than that of the higher fit subjects. In the interest of elucidating the groups' responses to the different tasks, the task mean as well as the means and standard errors of each group are graphed in Figure 1 (a, b, & c).

Tasks and Groups

All six adventure tasks evoked significant increases in urinary NE when compared to the non-challenge comparison periods (Tasks 1 & 8). This depicts the connection between NE and physical exertion. Considering this well established connection, it is reasonable to expect a difference in NE response between lower and higher fit subjects, as has been found in previous investigations. The most notable NE mean was obtained from Task 7. During both whitewater canoeing days (Tasks 6 & 7), all participants were equally active. There was no opting out of the canoeing activity. However, on the advanced climbing day (Task 4), most of the lower fit subjects completed or attempted only one climb, but the higher fit subjects' completed or attempted at least two or three climbs. Norepinephrine response was greater for the lower fit subjects during this task in spite of less physical exertion (Figure 1b). Al-

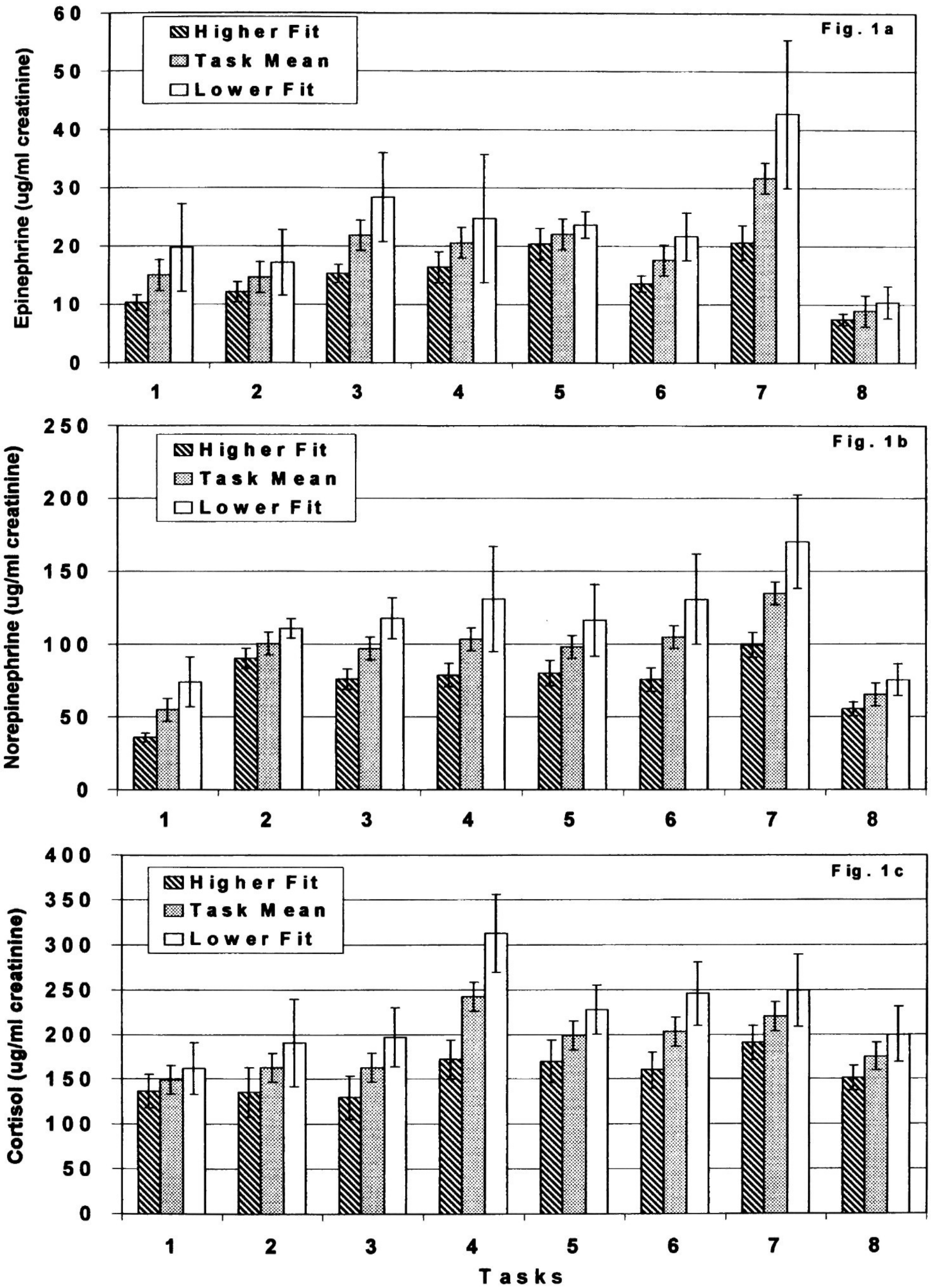

Figure 1. Tasks by Fitness Group and Overall Task Mean for a) Epinephrine, b) Norepinephrine, and c) Cortisol. *Note.* Tasks are: 1—Pre-course van ride, 2—Backpacking, 3—Introductory climbing and rappelling, 4—Advanced climbing and rappelling, 5—Ropes course, 6—Introductory whitewater canoeing, 7—Advanced whitewater canoeing, and 8—Post-course van ride.

though NE has been shown to be most reactive to physical exertion, this study's finding indicates the influence of other variables on NE response. One potential influencing variable is the difference between the higher and lower fitness groups' perceptions of task difficulty and their own efficacy. It is likely that a lower fit participant would perceive a physical task as more challenging, and due to a lack of previous physical involvement (yielding a lower fitness level) they would also have less confidence in their ability to complete the task successfully. Another speculation is that a significant stress response can be elicited by merely being in an environment where there is an expectation (although not a requirement) of active participation in a seemingly daunting task. Such could have been the case for Task 4 because the participants were free to choose their level of involvement. The anticipation of physical challenge along with perceptions of task difficulty and self-efficacy, could also be an influencing factor for the fitness group difference in NE and E levels for Task 1. Although this period required limited physical activity for everyone with the majority of time spent in a seated position, the lower fit subjects had higher levels of NE and E. Other researchers have also reported neuroendocrine increases with anticipation of challenge (Sothmann, et al., 1996).

In contrast to the NE responses, E and CT mean responses were much less reactive across the adventure tasks. The task that evoked the greatest increase in E, Task 7, had the greatest degree of actual risk of injury. All other tasks had readily apparent and direct safety systems, but the only safety systems for canoeing were: 1) the paddlers' skill in maneuvering their canoe and preventing capsizes, and 2) instructors stationed on the banks with throw ropes for those who capsized. Task 4 yielded the highest CT levels and apparent differences between fitness groups. Since E has been found to be more reactive in situations of emotional stress rather than physical exertion (Frankenhaeuser, 1981; Williams, 1986), and CT reactive to situations involving fear (Van de Kar, et al., 1991), it is reasonable to speculate that the increased E and CT excretion in the present study may reflect perceived threat. The more visually dramatic and exposed climb in Task 4 probably played a role in the increased CT responses compared to Task 3.

Another characteristic of Task 7 that could have influenced the increased NE and E responses was the fact that there were longer periods of physical involvement with fewer and shorter times for rest. Also, several of the rest breaks included looking at the upcoming rapid from the bank and discussing the best route to navigate. Although this scouting activity did not greatly increase the physical demands, the contemplation and discussion of the upcoming challenge and risk was more focused and directed than with the other activities.

Stress Adaptation or Toughening

If the cross-stressor adaptation theory (Sothman, 1996) and Dienstbier's (1987, 1989, 1991) model for physiological toughness are considered, outdoor adventure activities may fit the requirements for "stress toughening" especially well. Dienstbier hypothesizes that intermittent exposure to challenges, especially physical exercise, stimulates the sympathetic nervous system (SNS). This periodic stimulation makes the SNS more responsive and efficient during stress, without negatively affecting the immune system.The theorized toughening occurs from the conditioning of the physiological arousal responses and a sense of success and satisfaction from the exercise that has been viewed as a challenging experience rather than a distressing experience. More specifically, Dienstbier believes that through exposure to intermittent stressors, the SNS arousal base rate is lowered, but challenge or stress-induced SNS-adrenal-medullary arousal is strengthened, a resistance to brain catecholamine depletion is built and pituitary adrenal-cortical responses are suppressed. Outdoor adventure activities involve both physical exercise demands as well as opportunities for success and mastery of challenging tasks. Since Bandura (1977) has shown that experiences of success make the most significant contributions toward increased self-efficacy, and since most outdoor adventure programs are designed to provide confidence-building (Priest & Bunting, 1994) yet provocative physical and psychosocial challenges, participation in adventure tasks seem to offer positive options for active toughening.

A large body of research however, supports the relationship between coronary heart disease, hostility propensity, and elevated neuroendocrine levels (Barefoot, et al., 1983; Williams, 1986). Such a relationship indicates that a higher level of health correlates with a lower level of neuroendocrine response. This is opposed to the stress adaptation or physiologic toughening hypothesis that proposes higher fit people have an increased secretory capacity which enhances their ability to respond.

Although there is debate and conflicting findings regarding the actual neuroendocrine response, either augmented or attenuated, of high fit individuals to unfamiliar stressors, purposeful active toughening may be possible and beneficial to one's health. The higher fit participants in the present study exhibited lower neuroendocrine levels during the stress of adventure tasks when compared to the lower fit participants. Therefore, this result corroborates the findings of a majority of previous studies suggesting that physical fitness allows the body to maintain greater homeostasis of the neuroendocrine response system. A distinction that should be made however, is that Sothman's cross-stressor adaptation theory and Dienstbier's toughening hypothesis were developed from stress responses of "extremely high fit" subjects. The "higher fit" subjects of the present study could be described as "above average fitness" rather than "extremely high fit" (Golding, 1982). Thus, the results of the present study are illustrating the stress response for those of above average fitness, as opposed to the extremely high fit. Yet another possibility is that the nature of this study's stressors simply elicits a more exaggerated response than those previously used.

In addition to the ample evidence for the physiological benefits of regular exercise (Bouchard & Shephard, 1994), there is growing evidence to support its positive influence on self-perception, appraisal of anxiety, attentional focus, etc., (Landers & Petruzzello, 1994; McAuley, 1994; Chodzko-Zajko & Moore, 1994; Dishman, 1994). Investigators are also finding that the elements of predictability and behavioral control have a significant impact on the magnitude of physiological stress response. Therefore, an individual who has a habit of regular exercise and a high level of physical fitness is more likely to have a positive self-concept and to perceive a challenging/threatening task as less challenging or threatening than a lower fit peer.

The combined physical and psychosocial challenge of outdoor adventure activities is an excellent form of active toughening or purposeful stress adaptation. The repetitive nature of typical physical exercise, i.e. cycling, jogging, weight training, etc., renders the stress of exercise to be familiar or always similar (homotypic) (White, et al., 1993). These repetitive forms of exercise do not provide challenges with often-unexpected and unfamiliar (heterotypic) situational demands as do outdoor adventure activities. When considering physiological stress adaptation through outdoor adventure participation, the following points help with conceptualization:

1. Regular exercise, leading to an above average level of physical fitness, can enable a lower neuroendocrine response.
2. Individuals who exercise regularly and obtain an above average level of physical fitness, have probably experienced success in one or more physical activities. Successes increase self-efficacy, which may allow for a lower perception of threat.
3. Outdoor adventure participants experience a variety of expected and unexpected challenges, so they may not perceive unfamiliar challenges to be as unique as non-exercisers and non-adventurers.
4. In a situation of combined physical and emotional stress (meta-challenge), an individual with a habit of regular exercise and above average fitness does not exhibit greatly elevated neuroendocrine levels.

Figure 2 is an illustrated hypothesis of how these factors may have influenced the participants in the present study.

The increased participation by middle to older age adults in these physically and emotionally demanding adventure activities warrants further investigation of the associated stress responses. As knowledge is gained regarding the mechanism of stress response and its relationship to cardiovascular disease and the immune system (Sgoutas-Emch, et al., 1994: Light, Sherwood, and Turner, 1992), outdoor adventure tasks should continue being used for naturalistic stress investigations. Further research could explore the impact of personality variables (i.e., hostility propensity), and experience on psychophysiological responses to outdoor adventure participation, as well as comparisons of response magnitude between naturalistic adventure tasks and typical laboratory stressors. With more in-depth investigation, the perception of outdoor adventure being only for thrill-seekers may change.

Outdoor adventure activities may be living metaphors for the stress of 21st Century lifestyles. The increase in outdoor adventure participation may

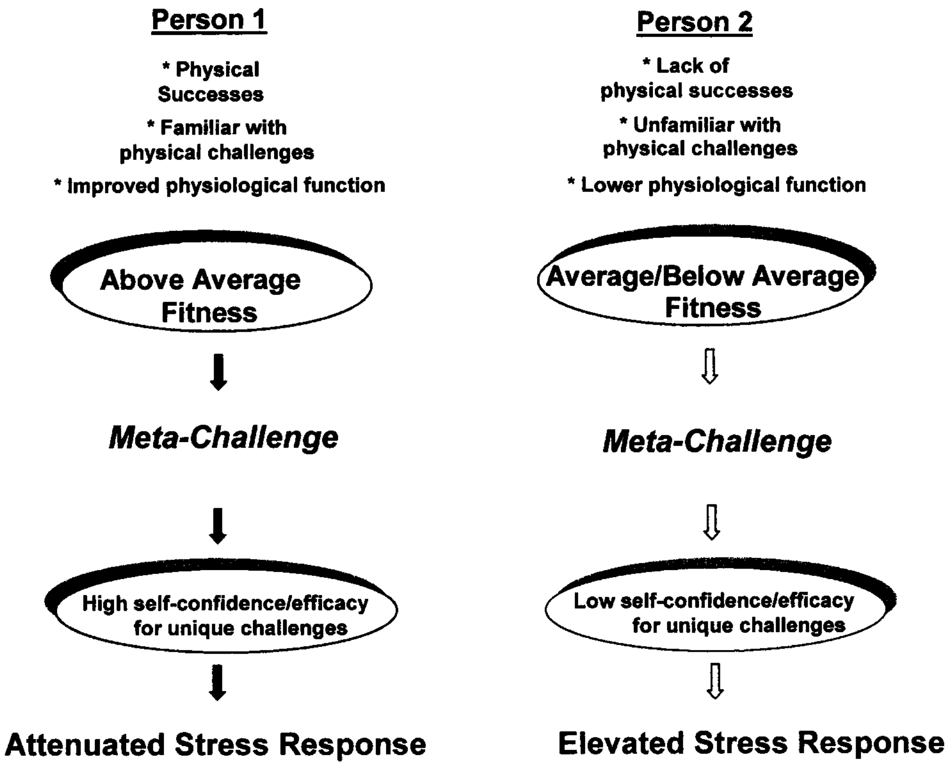

Figure 2. Meta-Challenge Response Model

actually be a survival reaction. To condition ourselves for life's demands, we are attracted to outdoor adventure pursuits that also present multiple types of demands, challenges and risks. Outdoor adventurers may be those who are consciously or unconsciously striving to gain resilience for a life of meta-challenge.

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