THE EFFECTS OF COGNITIVE STRATEGIES ON RUNNING PERFORMANCE

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A Thesis

Presented to

the Faculty of University Schools

Lakehead University

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in the

Theory of Coaching

****

by

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1980

ACKNOWLEDGEMENTS

The author would like to express a sincere thanks to Dr. Brent Rushall for his support and patient guidance in the development of this thesis.

Appreciation is also extended to Brian Kan, a fellow student, for donating many hours during data collection.

Finally, the author would like to acknowledge the cooperation and example of Coach Greg Holm and the dedication and effort put forth by the members of the Athletics North-West Track Club.

ABSTRACT

The purpose of this thesis was to examine the effects of various cognitive strategies on the performance of endurance runners in a maximum endurance sport-related task. The independent variables were the four forms of cognitive strategy presented to each subject (N=21). The dependent variables were the length of time that each S would perform at constant effort and intermittent heart rates during performance. The order of the treatment conditions was randomly selected from six 4 x 4 Latin squares. An ANOVA revealed that no one single treatment condition was superior to another. An orthogonal comparison revealed a significant difference in performance with a planned cognitive strategy as compared to an unaided condition. The performance of eight older and more successful runners was analyzed. No significant F ratio for treatments was revealed.

Nineteen subjects ran his/her best under a planned strategy (imagery manipulation, task specific, and/or voluntary distraction). Two subjects ran his/her best under an unaided condition. On posttest and postexperiment questionnaires subjects indicated the following: a) an awareness of which strategy prolonged his/her performance best, b) an ability to concentrate on the assigned strategy, c) that the experience was painful and, d) a preference for the voluntary distraction strategy. Although the voluntary distraction strategy was preferred, more best performances occurred under the task specific strategy. Pretest expectations to do well or poorly did not seem to affect performance.

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Chapter 1

INTRODUCTION

Statement of Purpose

The purpose of this thesis was to examine the effects of various cognitive strategies on the performance of athletes in a maximum endurance sport-related task.

Significance of the Study

Scientists and coaches have an increased awareness of the importance of psychological factors in sporting events. Any contribution made to enhance the knowledge of what psychological factors cause differences between good and great athletic performances undoubtedably would be of significance. Why some athletes seem to endure while others do not has perplexed and frustrated this investigator as well as most other concerned observers.

Many studies have dealt with the effects of psychological factors on pain. Findings support the fact that cognitive strategies are successful in altering pain coping capacities (Beers & Karoly, 1979; Blitz & Dinnerstein, 1971; Chaves & Barber, 1974). There are indications that individuality and situation might favor different alleviation processes. At the same time, evidence suggests that multiple strategies may be employed successfully to raise general pain tolerance (Scott & Barber, 1977). A strong possibility exists that these strategies might be effective in reducing the pain of athletic fatigue.

Investigators have speculated on improving sport performance by manipulating thoughts and feelings. Few, however, have systematically tried to implement specific psychological strategies and to study their effects on athletic performance. Crossman (1977) attempted to assess the effectiveness of cognitive strategies on the maximum endurance running performance of intercollegiate wrestlers. Although not sucessful, two interesting aspects of Crossman's work were: a) all subjects preferred strategy conditions to unaided conditions, and b) most subjects could not relate which strategy maximized their performance. Unlike Crossman's study this experiment tested athletes in a task specific to their training (i.e., endurance runners performing a maximum endurance run). The use of athletes in a task-specific environment should produce a consistency of performance, across trials, which Crossman's study lacked.

Three areas of criticism of Crossman's design were: a) the lack of concern for the expectation factor in improving performance, b) the inadequate assessment of the extent to which athletes actually experienced pain, and c) the lack of an accurate indication of the extent to which the subjects actually employed their assigned strategies. Improvements in research design could yield new and valuable information which might clarify the discomfort of athletic fatigue as a type of pain.

Significant results from this study would have great implications for understanding athletic performance. Applications to real-life situations could cover a continuum from recreational fitness pursuits to the performance of elite athletes. The discovery of pain strategies employed successfully by athletes could extend pain research to a new sphere of psychological aid.

Delimitations

This thesis was delimited to the study of the performance of club runners on the specific task of treadmill running. The runners varied in ability from novice to national calibre. Their ages varied from 12 to 28 years.

The independent variables were the four cognitive strategies employed by the runners. The four strategies were as follows: a) unaided, b) imagery manipulation, c) task specific, and d) voluntary distraction. These strategies were selected because: a) they have been employed successfully in pain reducing experiments, b) they have explicit methodologies, c) they respresent a gradient of content emphasis from task to environment, and d) they are easily adaptable to sporting situations. The voluntary distraction strategy and the imagery manipulation strategy have been employed by endurance runners (Moore, 1976).

The dependent variables were the length of time that each subject could perform under a specific maximum work load and the subject's heart rate while performing under the load.

Pretests for the purpose of establishing a baseline were conducted during a ten day period immediately prior to the experimental testing. The four treatments were administered weekly at the same time for four weeks. The possibility of mortality due to illness or injury, was always present.

Limitations

This study was limited to the performance of an intact group of 21 club runners. The following assumptions were made: a) that the subjects were capable of understanding and employing the learned strategies, b) that the strategies were performed as instructed, c) that the carry-over effect of the strategies for treadmill running would be useful for competitive endurance running and possibly for other similar sport situations such as endurance swimming, d) that the pain control strategies would be applicable for controlling extreme fatigue, e) that the pain from fatigue is a major factor in limiting endurance performance, and f) that any performance increases were due to treatments and not to subject expectancies.

Definitions

Cognitive Strategy refers to a consistent perceptual methodology or mental plan employed by an athlete during an endurance activity in order to alter or transform the experience of pain from extreme physical fatigue.

Unaided Strategy: This refers to the uninstructed individual plan, or lack of it, employed by the athlete as a thought control procedure during an athletic feat.

Task Specific Strategy: This refers to the instructed plan which involves total concentration on technique associated with the activity as a thought control procedure during an athletic feat.

Voluntary Distraction Strategy: This refers to the implementation of one of numerous uninstructed self-chosen plans such as counting backwards, goal setting, or singing as a thought control procedure during an athletic feat.

Imagery Manipulation Strategy: This refers to the instructed plan which involves fantasizing as a thought control procedure during an athletic feat.

Maximum Endurance is the highest degree of effort in magnitude and quantity over an extended period of time.

Pain Tolerance is the ability to endure the physical and psychological noxious stimuli which results from a maximum performance in treadmill running.

Performance time refers to the number of seconds that a subject runs under a specific condition in an attempt to perform at maximum effort.

Heart rate refers to the number of ventricular contractions per minute as recorded on an electrocardiogram.

Club runners refers to the 21 subjects, both male and female, ages 12 to 28 years, who range in ability from novice to elite. The runners compete provincially and nationally. They had just completed a training schedule involving running one hundred miles a week.

Chapter II

REVIEW OF LITERATURE

The experimental success of cognitive strategies in altering the effects of pain has been limited to specific pain or pain threshold and pain tolerance. Although athletes deal more effectively with pain than non-athletes (Ryan & Kovacic, 1966; Walker, 1971), experimentation has not shown that the athlete's ability to alter the effects of pain are due to the employment of cognitive strategies. Furthermore, an assumption must be made analogizing to specific pain and the severe discomfort of lactic acidosis. Moore (1976) reported evidence that non-world class marathoners used cognitive strategies to dissociate their thoughts from pain. However, not one of 20 world class marathoners admitted to Moore (1976) the use of cognitive strategies to dissociate or distract themselves from the pain of maximum endurance running.

The relationship between pain threshold and pain tolerance is unclear. Clarke and Bindra (1956) reported a high correlation between pain threshold and pain tolerance. Gelfand (1964) reported a low correlation. Gelfand (1974) concluded that experimentation influenced pain tolerance more than pain threshold, because pain tolerance was more heavily loaded with psychological variables than pain threshold. Taylor (1979) concluded that these psychological components could be as important in limiting human endurance performance as physiological components. Kane (1979) agreed that psychological factors could ultimately be the decisive factor between success and failure in a competitive sport situation.

Cautela (1977) provided a conceptualization of pain which is of assistance when comparing the pain endured by athletes to specific experimentally induced pain. According to Cautela, pain is a response with one or two of the following characteristics: a) a verbal report of pain, b) behavior such as moaning, groaning or grimacing, and c) avoidance of stimuli perceived as noxious. Cautela also indicated that the degree of pain is dependent upon where the subject, according to past experience, placed it on an unpleasant continuum. Since these characteristics are appropriate for the discomfort state associated with maximum efforts in prolonged sporting events, it is reasonable to expect relevant pain research as having applicability to the "pain" of sports performances.

The effects of pain have been altered by many different types of cognitive processes. Blitz and Dinnerstein (1971) effectively increased the pain thresholds of subjects who were holding their hands in ice water, by having two groups of subjects concentrate on different distraction strategies. In one method the subjects were to dissociate from the pain and concentrate only on the task. In the other method the subjects were to concentrate on the pain and cold and associate the sensations with pleasant nonaversive feelings. Barber and Cooper (1972) reported that distractions of listening to a story or adding aloud were only slightly effective. This may have resulted because a comparison control group effectively used their own methods of distraction. Beers and Karoly (1979) measured the effectiveness of the following four strategies on pain threshold and pain tolerance: a) rational thinking, b) compatable imagery, c) incompatable imagery and d) task irrelevant. All of the above strategies employed by the subjects were successful in raising pain threshold and pain tolerance. However, the rational thinking and compatable imagery strategies were generally the most effective. Spanos, Horton, and Chaves (1975) reported that relevant strategies (imagining a situation inconsistent with pain), were more successful in increasing pain thresholds than irrelevant strategies (imagining a situation unrelated to pain). The conclusion however, applied only to subjects who already possessed a high pain threshold. The explanation for the strategies being ineffective for subjects with low pain thresholds was that these subjects probably had insufficient time to get involved in their strategies.

Barber and Hann (1962) concluded that hypnotically-suggested analgesia was no more effective than waking imagined analgesia in pain reduction. Both methods reduced verbal reports of pain, breathing irregularities, and muscle tension. Autonomic responses (i.e., cardiac acceleration and skin resistance) were not reduced. Spanos, Radtke-Bodorik, Ferguson, and Jones (1979) pursued further the effectiveness of hypnotic suggestion and cognitive strategies on the reduction of pain. After subjects were previously stratified for hypnotic susceptibility they were assigned to one of four different groups as follows: a) hypnosis plus analgesic suggestion, b) hypnosis alone, c) suggestion alone, and d) no hypnosis - no suggestion. Hypnotic and nonhypnotic subjects did not differ in their strategy use or in their report of pain reduction.

The reviewed literature suggested that instructions which affect thinking were effective in reducing the effects of pain. Relevant strategies were more effective than irrelevant strategies. Dissociating oneself from pain by imagining the pained area as numb or insensitive was also an effective strategy.

Generally, the effectiveness of cognitive strategies was independent of the type of noxious stimulus used. Clarke and Bindra (1956) found no difference in pain threshold or pain tolerance levels when using electrical, thermal, and mechanical stimuli. Davidson and MacDougall (1969) found no consistent generalization of pain tolerance. Davidson and MacDougall (1969) suggested that the electrical stimulus used by Clarke and Bindra (1956) may have masked the effects of the thermal and mechanical stimuli. However, Scott and Barber (1977) found cognitive strategies to be effective with several types of pain.

The effectiveness of cognitive strategies in pain reduction might be because they direct attention away from the painful stimulus (Blitz & Dinnerstein, 1971; Spanos et al., 1979). The success of the strategies was related to the concentrating ability of the subject (Chaves & Barber, 1974; Spanos et al., 1975). Scott and Barber (1977) reported that the effect of pain produced by cold or pressure was decreased far more effectively if the subject combined the five following strategies: i) attempting not to be bothered by pain, ii) concentrating on other things, iii) dissociating oneself from pain, iv) reinterpreting the sensations as not painful, and v) imagining the pained area as numb or insensitive. Multiple strategies with long preparations or short preparations raised pain tolerance by 100%.

Strategies were more effective if the subject was involved in the strategy planning and control (Gelfand, 1964; Kanfer & Seidner, 1973; Staub, Tursky & Schwartz, 1971). Self-controlled strategies probably involve predictive information which minimizes the degree of threat and anxiety produced by pain (Bowers, 1968). Staub and Kellett (1972) concluded that permissive strategies were more effective because they contained items already validated by the subject's experiences. Chaves and Barber (1974), aware of the expectancy factor in the success of cognitive strategies in pain reduction, designed an experiment to determine the amount of the reduction that was due to expectancy. Chaves and

Barber (1974) reported that pain reduction occurred for both cognitive strategy employment groups and expectancy groups; but, that the groups employing cognitive strategies showed greater reductions.

Brown, Fader, and Barber (1973) using two types of pain stimulus, cold and pressure, concluded that response to pain had no relationship to personality. Nowlen (1974) compared the pain responses of four groups of athletes and also reported no relationship between pain and personality factors. However, the reviewed literature continually referred to two types of subjects classified by their low or high pain thresholds. The sensitizers and repressors (Spanos et al., 1975) and the catastrophizers and noncatastrophizers (Spanos et al., 1979) referred to types of subjects who probably differed in their ability to sustain concentration on their strategies and may have focused their attentions on the unpleasant aspects of the pain producing situation.

The effectiveness of cognitive strategies in reducing the effects of pain was dependent upon: a) the ability of the subject to concentrate, b) the degree of involvement and control by the subject, c) the type of strategy, whether relevant or irrelevant, single or multiple, or permissive or nonpermissive. The expectancy of the subject for the strategy to be effective probably contributes to the success of the strategy. However, expectancy alone did not produce as great a reduction in pain as did the strategies.

Athletes had a higher tolerance to pain than nonathletes (Ryan & Kovacic, 1966). Walker (1971) suggested that the athlete was capable of intense concentration which enables him/her to tolerate pain and endure longer but, after experimentation reported that distraction strategies did not affect pain tolerance. Walker concluded that the nature of the electrical pain stimulus used did not give enough time for the subject to get involved in a strategy. Ryan and Kovacic (1966) suggested that the ability to withstand pain seems essential to successful athletic performance.

Crossman (1977) investigated the effects of cognitive strategies on a maximum endurance task. Although no significance was found, mean performance time for each of three strategies was longer than the mean performance time with a no-strategy control condition. Crossman (1977) concluded that the lack of significance may have been attributable to lack of consistency in performance resulting from the subject's lack of specific training for the task of endurance running.

The effectiveness of cognitive strategies in pain reduction is probably attributable to the redirection of the subject's attention away from the noxious stimulus. It seems possible that an athlete capable of intense concentration would be able to distract or dissociate him/herself from the pain of accumulated fatigue. The demonstration of the use of cognitive strategies for increasing endurance performances would be a significant contribution to the field of sport coaching.

Chapter III

METHODS AND PROCEDURES

Hypotheses

1. Null Hypothesis

There is no difference between the treadmill running performances of endurance runners when employing each of four different cognitive strategies.

2. A Priori Hypothesis

The running performance of endurance runners will be increased when a planned cognitive strategy is used as opposed to a condition where no planning is employed.

Research Design

In this experiment 24 subjects were randomly selected and paired with all possible sequence combinations of the four independent variables. The order of the treatment conditions was randomly selected from six 4 x 4 Latin squares. Mortality reduced the number of subjects to 21. The research design was fully balanced because of the random assignment of treatments and order. A statistical significance level of .05 was chosen rather through convention than for any other reason.

Independent and Dependent Variables

The independent variables, as follows, were the four conditions under which the subjects performed: a) unaided condition, b) imagery manipulation condition, c) task specific condition, and d) voluntary distraction condition. The unaided condition was designed as a replication of thinking during performance that was usual for each runner. The imagery manipulation condition was selected to enable the subjects to concentrate on the pleasurable aspects of running through a scenic countryside (i.e., beautiful scenery, fresh cool breeze, joy of running). The task specific condition was designed to enable the subject to concentrate on the specific techniques of running and consequently distract himself from the discomfort of running. The fourth condition, voluntary distraction, permitted the subject to incorporate a strategy or strategies of his/her own design.

These four conditions were selected because: a) they had been employed successfully in previous pain reducing experiments, b) they represented a gradient from relevant to irrelevant strategies, c) they had explicit methodologies, and d) they were easily adaptable to sporting situations.

One major dependent variable and one minor dependent variable were measured. Performance time, the major dependent variable, best measured the effects, if any, of the independent variables. Heart rate, the minor dependent variable, was a good measure of physiological change resulting from performance.

Posttest and postexperiment questionnaires (see appendix C) were administered in order to obtain information regarding the following: a) the amount of discomfort (pain) experienced by the subject, b) the degree and nature of the subject's pretrial expectancy, c) the subject's estimation of the relative length of performance, d) the percentage of time that the subject was able to employ the instructed strategy, e) the subject's preference and estimate of effectiveness of each condition, and f) a description of factors that might have confounded the performance.

Subjects and Sampling

Twenty-four endurance runners from the Athletics North-West Track Club were selected on the basis of availability, suitability, and interest. The subjects were tested in the physiology laboratory of the C.J. Sander's Fieldhouse at Lakehead University. The runners, females (8) and males (16), from 12 to 28 years of age, varied in calibre from novice to national levels.

Controls

Numerous controls were implemented in order to avoid, distribute, or measure the effects of potential contaminating extraneous variables.

Each subject was pretested in order to establish a speed and grade at which the subject could perform maximally for a period of 8 to 12 minutes (see appendix G). This speed and grade was consistent for all trials. The treadmill was calibrated for each subject immediately prior to each trial.

The subjects, whenever possible, ran at the same time of the same day each week. Subjects were asked to prepare for the run as if they were preparing for a race (i.e., eat intelligently, no alcoholic beverages, obtain adequate sleep). The subjects were thoroughly informed of the importance of consistency in routine for a period of 48 hours before each trial. The coach regulated the athletes' weekly training schedules in order that the treadmill run would be part of a standardized routine.

Clocks and timers were hidden so that no subject would have any visual cues as to the length of performance. No performance feedback information was given to any subject. Instructions for each condition were standardized with the use of a tape recorder. All climate conditions (eg., room temperature) were constant for each treatment across all trials.

Recording errors and measurement errors were minimized by using standardized recording sheets (see appendix D) and by duplicating measurements (eg., two timers) wherever possible.

In order to insure that the subjects would employ the requested strategy, adequate time was allotted for diligent and patient preparation by the subject and the experimenter. Repeated instructions and written preparations previous to performance; visual and auditory cues during performance; and posttest subject estimations of the percentage of time the strategies were employed, facilitated and measured the maximum use of the requested strategies.

Subjects and treatment sequences were randomly selected and paired.

Measurement Techniques

Each subject ran three pretest trials. The purposes of the pretest trials were as follows: a) to teach the subject how to mount, dismount, and run on the treadmill, b) to adapt the subject to the electrode attachments and the experimental environment, and c) to attempt to stabilize performance for the establishment of a baseline.

For each pretest the subject was attached to the monitoring system, given a warm-up, and then after the treadmill was calibrated, instructed to run until it was impossible to continue. Warm-ups were standardized as 90 seconds at 6 mph or 7 mph, 90 seconds at 7.5 mph or 9 mph, and then the speed was increased to the pretest level. The speed and grade for each pretest was adjusted systematically in order to accommodate an 8 to 12 minute maximum run. A previously prepared recording sheet was used to accurately record the performance for each pretest. Performance time, the time from remounting after calibration to the termination of the run, was measured by two digital stopwatches. Heart rate was monitored at rest, during the warm-up, and at every minute interval during the performance after the first three minutes.

When it was impossible to continue running, the subject was instructed to grasp the support bars. The grasping of the support bars terminated the performance. The subject warmed down for a brief period.

Experimental Tests

The following experimental procedures were replicated across subjects and treatments. The laboratory was prepared previous to the arrival of the subjects. The treadmill was warmed, the room temperature was checked, the subject work area was prepared, and all the necessary timers and recording sheets were checked and positioned. Two experimenters were present, each having specific functions. On arrival the subject was shown to the preparation area to listen to one of four taped instructions as follows:

1. Unaided - After the treadmill is calibrated wait for the operator's signal. When signalled to do so remount the treadmill and straddle the running surface. When you are ready, grasp the support bars and start striding. When you are comfortable, let go of the bars. I'd like you to run on the treadmill until it is impossible for you to continue. When you regrasp the support bars at the sides of the treadmill I'll know that it is impossible for you to continue running. Please try not to use plans that you have previously employed.

   Allow me to repeat your instructions.

2. Imagery Manipulation - For this run I would like you to imagine yourself enjoying a run during a beautiful day in the scenic countryside. During your run think of nothing else. Concentrate on enjoying the beautiful trees, the sounds of the birds, the cool fresh breeze, and the freedom of running. As you continue your run appreciate the joy of running and concentrate on enjoying the beautiful surroundings.

Begin now to write down words or phrases that will help you to concentrate on the freedom of your run and the beautiful surroundings. Some examples to get you started are written on a paper in front of you. After you have completed your list of words and phrases study and learn them, so that when you do get on the treadmill, you will be able to concentrate only on them.

When you have learned your words and phrases, I will put them on the wall in front of the treadmill so that you may refer to them while running. When you feel that you have learned the list of words and phrases on which you are going to concentrate get on the treadmill. I'd like you to think of the beautiful day and surroundings at all times and to run until it is impossible to continue.

Allow me to repeat your instructions.

3. Task Specific - For this run I would like you to focus your attention and concentrate entirely on your running technique. As you run think always of your running technique. For the entire run concentrate on your head position, your arm movement, your stride length, and your running rhythm. Remember, you are to think only of your technique, Concentrate, at all times on rhythm, stride length, arm position, head position, and any other features of your technique with which you are familiar.

   Begin now to write down words or phrases that will help you to think of running technique. Some examples to get you started are written on a paper in front of you. After you have completed your list of words and phrases, study and learn them, so that when you do get on the treadmill you will be able to concentrate only on them.

   When you have learned your list of words and phrases, I will put them on the wall in front of the treadmill so that you may refer to them while running. When you feel that you have learned the list of techniques on which you are going to concentrate, get on the treadmill. I'd like you to concentrate on technique at all times and to run until it is impossible to continue.

   Allow me to repeat your instructions.

4. Voluntary distraction - For this run I would like you to think of things that will take your mind away from your running. Please do not use any of the methods previously employed. Use plans or ways of

thinking that you have used before or can make up now. Think of anything you wish that will distract you from your running. You may sing, count, recite poetry, or think of anything that you wish, except your running.

Start to prepare yourself now! Write down some words or statements that will help you to concentrate on those things that you choose. I will put these reminders on the wall in front of you while you are running. Now and then I will remind you to concentrate on those things you have written down. I'd like you to run in this manner until it is impossible for you to continue.

Allow me to repeat your instructions.

After listening to the instructions, the subject was assisted by the experimenter, if necessary, to prepare his list of words and phrases. The subject was then attached to the monitoring system, the preexercise pulse rate was recorded, and then the warm-up began. The monitoring equipment was tested during the warm-up. After warming-up, the subject straddled the running surface while the treadmill calibration was checked. When ready, the subject grasped the treadmill support bars and started striding. When the subject released the bars the stopwatches started. The run duration was terminated when the subject regrasped the bars. Heart rate was monitored on the E.C.G. at every minute interval after the first three minutes of the running performance. After the first three minutes, the subject was reminded, at intervals varying from 30 to 45 seconds, to concentrate on his preparation content. Auditory cues were given by tape recording preparations specific to each strategy (see appendix E). The unaided condition required no cueing.

Performance time was recorded as the length of time that elapsed from the moment the subject released the supporting bars until he/she regrasped them again. The heart rate was recorded as the mean of the last three monitored rates.

After the end of each test the subject completed a posttest questionnaire. After the fourth test the subject completed the post-experiment questionnaire.

Apparatus

A Quinton Instruments intermediate size treadmill (model 18-60), was used for this experiment. The treadmill was equipped with an electrical elevation unit (0 - 40^{o}) and an electrical driven speed change mechanism. The standard speed range of the treadmill was 1.5 to 15 mph.

A Cambridge VS4 electrocardiograph unit was used for monitoring heart rate. Each subject was attached to the electrodes prior to the warm-up. Time for warm-up was regulated with the aid of a Gray-lab timer. Performance time was measured with two AMF American digital stopwatches.

A cassette tape recorder played standardized instructions for each treatment. Strategy preparations were recorded with magic marker on 24" x 30" bristol board.

Data Analysis

Time for individual performance for each treatment was recorded in seconds. Heart rate scores were recorded as the number of beats per minute.

An analysis of variance (Edwards, 1972) was used to determine if there was a significant difference in performance time or heart rate between the four independent variables.

An a priori orthogonal comparison (Hays, 1963; Winer, 1962) was performed to see if there was a significant difference in performance time between the unaided and aided treatments. This served as a test of the alternative hypotheses.

Performance improvements for treatments for all subjects were calculated by expressing the mean performance as a percentage of the lowest mean performance.

The subjects' responses to the posttest and postexperiment questionnaires were tabulated in order to determine an index for each of the following: a) the subject's preference for condition, b) the subject's estimate of which condition was most effective for prolonging performance, c) the subject's estimate of the percentage of time that he was able to use the instructed strategy, d) the subject's estimate of the degree of discomfort experienced and the interpretation of this discomfort as painful, and e) how the subject's expectation of performance compared to his/her actual performance.

Chapter IV

RESULTS

All aided conditions produced greater mean performance times than the unaided condition. In comparison to the unaided condition, the imagery manipulation condition was greater by 9.7%, the task specific condition by 10.8%, and the voluntary distraction condition by 11.6% (see Table 1).

TABLE 1

MAXIMUM, MINIMUM, AND MEAN PERFORMANCE TIMES (SECONDS) FOR EACH TREATMENT CONDITION.

STATISTIC	TREATMENT CONDITION UNAIDED	IMAGERY MANIPULATION	TASK SPECIFIC	VOLUNTARY DISTRACTION
MAXIMUM	910	1216	1012	1419
MINIMUM	425	435	451	533
MEAN	682.67	749	756.53	761.81
STANDARD DEVIATION	147.85	199.95	155.07	199.55
% IMPROVEMENT OVER UNAIDED CONDITION	0	9.7	10.7	11.6

The mean heart rate for each condition was as follows: a) unaided 182.9 bpm, b) imagery manipulation 183.71 bpm, c) task specific 183.52 bmp, and d) voluntary distraction 185.0 bpm (see Table 2).

Of the 21 subjects completing the experiment, 19 performed best under an aided treatment condition. Four subjects performed his/her best performance for the imagery manipulation condition; eight subjects performed his/her best performance for the task specific condition; and

TABLE 2

MAXIMUM, MINIMUM, AND MEAN HEART RATES
FOR EACH TREATMENT CONDITION.

STATISTIC	UNAIDED	TREATMENT CONDITION IMAGERY MANIPULATION	TASK SPECIFIC	VOLUNTARY DISTRACTION
MAXIMUM	195	200	200	200
MINIMUM	165	171	168	173
MEAN	182.9	183.71	183.52	185.0
STANDARD DEVIATION	8.94	7.84	9.39	8.41

seven subjects performed his/her best performance for the voluntary distraction condition (see Table 3). The unaided condition produced almost as great a number of worst performances as the three aided conditions combined (see Table 3).

TABLE 3

FREQUENCIES OF RANKS OF RUNNING PERFORMANCES FOR
THE FOUR TREATMENT CONDITIONS.

PERFORMANCE RANKS	UNAIDED	TREATMENT CONDITION IMAGERY MANIPULATION	TASK SPECIFIC	VOLUNTARY DISTRACTION
FIRST	2	4	8	7
SECOND	3	5	6	7
THIRD	6	8	4	3
FOURTH	10	4	3	4

An ANOVA for the performance time data revealed no significant treatment difference although the means for the aided conditions were greater than for the unaided condition (see Table 4). The null hypothesis, that no single treatment condition would be different to the control, was accepted.

TABLE 4

ANALYSIS OF VARIANCE FOR PERFORMANCE TIME DATA (SECONDS).

SOURCE	SS	df	MS	F
TOTAL	2,723,566.32	83		
ORDER	42,404.32	3	14,134.8	0.83
TREATMENTS	85,145	3	28,381.67	1.66
SUBJECTS	1,619,587	20	80,979.35	4.73[a]
ERROR	976,430	57		

COMPARISON OF MEANS

UNAIDED	IMAGERY MANIPULATION	TASK SPECIFIC	VOLUNTARY DISTRACTION
682.67	749	756.53	761.81

[a] significant at .05

An a priori orthogonal comparison of the mean of the unaided condition with the means of the aided conditions revealed a significant difference (F = 4.87; df 1, 57; $p < .05$). This indicated that the aided conditions had a combined effect which were significantly different from the unaided condition. Thus, the alternative hypothesis was accepted.

An ANOVA for heart rate revealed that no significant difference existed between the treatment conditions. However a significant F ratio for main effects for subjects and for order was revealed (see Table 5).

TABLE 5

ANALYSIS OF VARIANCE FOR HEART RATE FOR EACH TREATMENT CONDITION.

SOURCE	SS	df	MS	F
TOTAL	6386.1	83		
ORDER	64.4	3	21.47	3.35[a]
TREATMENT	48.8	3	16.27	2.54
SUBJECTS	5907.6	20	295.38	46.08[a]
ERROR	365.33	57	6.41	

[a] significant at .05

From the observation of the experimenter and from inspection of the data, it was suggested that the older and more successful runners were able to utilize a strategy more effectively. The data of eight male runners who achieved outstanding success previous and subsequent to the experiment were analyzed (see Appendix B). The results of the appropriate ANOVA are presented in Table 6. A nonsignificant F ratio for treatments was revealed although the range of means for the four conditions was greater than the range of means for all subjects (see Table 6).

On the basis of ANOVA results for performance time and heart rate the null hypothesis could not be rejected. The directional hypothesis was accepted on the basis of the orthogonal comparison.

Of the 21 subjects that completed the experiment, 14 subjects preferred the voluntary distraction condition, two preferred the unaided condition, three preferred the imagery manipulation condition, and two preferred the task specific condition (see Table 7).

TABLE 6

ANALYSIS OF VARIANCE FOR PERFORMANCE TIME FOR THE MORE MATURE AND SUCCESSFUL SUBJECTS.

SOURCE	SS	df	MS	F
TOTAL	887,108.72	31		
ORDER	28,821	3	9.607	0.49
TREATMENTS	60,886.37	3	20,295.46	1.03
SUBJECTS	443,978.25	7	63,425.46	3.23[a]
ERROR	353,685.62	18	17,671.16	

COMPARISON OF MEANS

UNAIDED	IMAGERY MANIPULATION	TASK SPECIFIC	VOLUNTARY DISTRACTION
640.6	727.9	726.5	757.4

[a] significant at .05

Twelve subjects were able to correctly estimate the condition which was most effective for prolonging his/her running performance. Ten of these twelve subjects ran his/her longest performance time under his/her preferred condition (see Table 7).

The mean of the estimated percentage of the performance time that the subjects were able to concentrate on the assigned strategy for each aided condition was as follows: a) 75.2% for imagery manipulation, b) 81.0% for task specific, and c) 86.0% for voluntary distraction. Twelve subjects reported the highest estimate of the ability to concentrate on the assigned strategy coincident with his/her longest running performance (see Table 7). This result might indicate that a strategy's effectiveness might be related to the subject's ability to concentrate while

TABLE 7

RESULTS OF PREEXPERIMENT AND POSTEXPERIMENT QUESTIONNAIRES FOR EACH OF THE TREATMENT CONDITIONS FOR SUBJECTS 1 TO 11.

SUBJECT AND TREATMENT ORDER	PREFERENCES			UNAIDED		TREATMENT CONDITION IMAGERY MANIPULATION			TASK SPECIFIC			VOLUNTARY DISTRACTION		
	a	b	c	d	e	%	d	e	%	d	e	%	d	e
1. ABCD	D	B	B	8 (YES)	—	85	6 (YES)	Y/Y	70	8 (YES)	N/N	90	7 (YES)	Y/Y
2. BCDA	D	D	D	5 (NO)	N/N	75	5 (NO)	—	75	6 (NO)	N/N	95	5 (NO)	N/Y
3. CDAB	A	D	B	8 (YES)	—	45	8 (YES)	N/N	85	8 (NO)	—	80	8 (YES)	Y/Y
4. DABC	B	B	B	2 (YES)	N/Y	75	4 (YES)	N/Y	50	4 (YES)	Y/N	50	5 (NO)	—
5. BCAD	C	C	C	8 (YES)	N/N	65	6 (NO)	—	90	8 (YES)	Y/Y	95	9 (YES)	Y/N
6. CDBA	C	D	A	6 (YES)	Y/N	90	2 (NO)	Y/Y	90	6 (YES)	—	90	4 (YES)	Y/N
7. DACB	D	D	D	5 (YES)	Y/N	70	6 (YES)	—	80	2 (NO)	N/Y	85	2 (YES)	—
8. BACD	D	D	D	6 (NO)	Y/Y	75	7 (NO)	—	75	7 (NO)	N/N	100	7 (YES)	Y/Y
9. CBDA	D	D	D	8 (YES)	N/N	85	3 (NO)	Y/N	85	5 (NO)	—	95	6 (NO)	Y/Y
10. DCAB	D	D	D	1 (NO)	N/N	100	4 (NO)	N/N	95	4 (YES)	N/N	90	5 (YES)	—
11. ADCB	C	D	D	7 (YES)	—	75	7 (YES)	N/N	90	5 (YES)	Y/Y	90	7 (YES)	Y/N

Continued on next page.

TABLE 7 (continued)

RESULTS OF PREEXPERIMENT AND POSTEXPERIMENT QUESTIONNAIRES FOR EACH OF THE TREATMENT CONDITIONS FOR SUBJECTS 12 TO 21.

SUBJECT AND TREATMENT ORDER	PREFERENCES			UNAIDED		TREATMENT CONDITION: IMAGERY MANIPULATION			TASK SPECIFIC			VOLUNTARY DISTRACTION		
	a	b	c	d	e	%	d	e	%	d	e	%	d	e
12. CBAD	D	D	D	1 (NO)	Y/N	90	6 (YES)	Y/N	100	5 (YES)	—	100	2 (NO)	Y/Y
13. DCBA	B	D	D	6 (NO)	Y/Y	90	9 (YES)	Y/Y	80	8 (YES)	N/N	95	10 (YES)	—
14. ACBD	C	D	D	6 (NO)	—	85	4 (NO)	N/N	80	7 (YES)	Y/Y	100	9 (YES)	Y/Y
15. BDCA	B	B	B	8 (YES)	N/N	75	1 (NO)	—	80	4 (NO)	N/N	80	4 (NO)	Y/N
16. CADB	C	D	D	4 (NO)	N/N	40	5 (NO)	N/N	80	4 (NO)	N/Y	90	4 (YES)	N/N
17. DBAC	C	D	D	10 (YES)	N/N	40	9 (YES)	Y/N	60	10 (YES)	Y/Y	75	6 (YES)	—
18. ACDB	C	A	C	7 (NO)	—	85	7 (NO)	—	90	6 (NO)	Y/Y	50	9 (YES)	Y/N
19. BDAC	A	A	A	3 (NO)	N/Y	70	3 (NO)	—	60	3 (NO)	Y/N	85	3 (NO)	Y/N
20. DBCA	B	C	C	7 (YES)	Y/N	90	7 (YES)	N/Y	90	8 (YES)	Y/N	80	7 (YES)	—
21. CDAB	C	D	C	9 (YES)	Y/N	75	7 (NO)	Y/N	95	8 (YES)	—	90	1 (NO)	Y/N
MEAN						75.2			81.0			86.0		

Key on next page.

KEY FOR TABLE 7

TREATMENT CONDITIONS

A - unaided
B - imagery manipulation
C - task specific
D - voluntary distraction

a) the condition under which the subject actually performed best.
b) the condition which the subject preferred.
c) the condition estimated by the subject that best prolonged performance duration.
d) the subject's estimate of degree of discomfort experienced and the interpretation of that discomfort as painful (yes or no).
e) the subject's expectation (if any) compared to the performance result (eg., expected to do better but did not).
%) the subject's estimate of the percentage of the performance time that he/she was able to concentrate on the assigned strategy.

using the strategy.

The range of discomfort as estimated by the subject on a scale from 0 to 10 (i.e., no discomfort to very severe discomfort, see Appendix C) varied from mild to very severe discomfort. Moderate, severe, and very severe discomfort were generally reported as painful. The subjects reported in 47 of 84 performances that the discomfort was painful. Six runners experienced his/her best performances without reporting pain (see Table 7).

The subject's expectation to perform well or poorly did not seem to affect his/her performance. The performance was in agreement with that expected (Y/Y or N/N) 35 times and in disagreement (Y/N or N/Y) 25 times. All combinations relating expectation and performance occurred (see Table 7). It should be noted that the expectancy before the trial to do well or poorly was not always related to the assigned strategy.

Chapter V

DISCUSSION

The results of this study indicated that the running performance of endurance runners will be increased when a planned cognitive strategy is used as opposed to a condition where no planning is employed. Nineteen of twenty-one runners produced their longest performance times while employing an assigned cognitive strategy and 20 of the 21 preferred planned strategy conditions. These findings indicate that coaches should consider the use of planned cognitive strategies with their endurance athletes when seeking quality performances.

An ANOVA revealed that no one single treatment condition was superior to another. The lack of statistical difference between the four conditions of performance may have been because the strategies had varied effects upon different individuals. This situation would explain the large observed performance variation with no one strategy condition yielding a significant statistical difference. The possibility existed that each of the strategies aided each of the subjects according to the skill with which the strategy was used. Individual preferences and performance effects may be better revealed if future researchers allowed the subjects to practise each strategy until they were equally skilled at each one's use.

The data indicated that there was a potential that the aided strategies might have had a combined effect which was obscurred by the variation introduced with the ANOVA for all conditions. An orthogonal comparison of the unaided condition with the planned conditions revealed that a significant difference in performance occurred when performing with an assigned strategy. The results, however did not indicate which strategy was best for prolonging performance.

There is a possibility that different runners may find greater success with different types of strategies. There is a need to develop a method of assessing which type of strategy could be most effectively used by each athlete.

The results of the analysis of performance data for the eight older and more successful subjects indicated two possibilities: 1) these subjects may have been able to use the assigned cognitive strategies more effectively and 2) a particular strategy might be more effective for these subjects.

Unlike Crossman's (1977) wrestlers, most of the endurance runners in this study showed a consistency of performance after three pretest trials (see Appendix G). The established speed and grade determined from the pretest trials was held constant for the test trials. Heart rate was intended to be an objective measure of constant workload. However, the ANOVA for heart rate data revealed a significant $\underline{F}$ ratio for the main effect of order. This effect was not found in a similar study by Crossman (1977). The effect may have been due to an adaptation to the training environment. Future researchers should give more consideration to this adaptation effect.

The indication by the majority of subjects (14 of 21) that they preferred the voluntary distraction strategy was not surprising to the experimenter. Although the voluntary distraction strategy was assigned it was not as restricted as the task specific and the imagery manipulation strategies. The voluntary distraction strategy in most cases represented a multiple strategy that had been validated by the subjects' experiences. Scott and Barber (1977) had reported that multiple strategies were more effective than single strategies and Staub and Kellett (1972) concluded that they were more effective than nonvalidated strategies.

The above information might be interpreted by coaches that permissive multiple strategies might be most effective for their runners. But, the preference for the voluntary distraction strategy may have been a factor of the athlete's familiarity with the content. However, an athlete's preference does not necessarily indicate that the selected strategy will facilitate the best performance.

A somewhat surprising result in this investigation was that although 14 subjects preferred the voluntary distraction condition, only six of those subjects actually ran their longest performance under that condition. Of the eight older and more successful runners only two preferred the voluntary distraction condition.

Two subjects preferred the task specific strategy condition but eight subjects actually ran their longest performance while employing this strategy. The task specific strategy despite its lack of preference may have the best potential for prolonging performances.

The voluntary distraction strategy, a multiple strategy, may allow, because of its familiarity, a less skilled user of a cognitive strategy to concentrate to a greater degree. But, the possibility exists that practice may increase the skill with which assigned strategies, such as the task specific strategy, can be used.

Even though seven subjects preferred different strategies, the reasons for the preferences, familiarity and involvement, were somewhat consistent. Of the two subjects who ran their longest performances during the unaided strategy condition, one actually employed a multiple strategy with which he was very familiar and the other confessed on the postexperiment questionnaire that the assigned strategies made him nervous.

Moore (1976) cited examples of non-world class marathoners who used various types of cognitive strategies. It would be expected that the endurance runners in this study would employ some sort of cognitive process when asked to perform without the aid of an assigned strategy. The responses to the question, "What were you thinking about during your run today?", on the posttest questionnaire for the unaided condition revealed that this was true. However, a significant difference existed. Only one runner in this study had employed a planned cognitive strategy before the experiment. The thoughts of the other subjects in the unaided strategy condition were random and generally concerned with any factor which might have been relevant at the time. A great number of aversive thoughts were reported. Thoughts concerning "sore legs", "sore back", "nausea", and "how painful it is to run at that speed" were examples of, the aversive content reported. It was common however, for subjects to set goals for themselves immediately before stopping. Counting backwards from 60 to 1 or running for another 100 strides were commonly employed.

Spanos, Radtke-Bodorik, Ferguson and Jones (1979) had referred to types of subjects who focused their attention on the unpleasant aspects of pain producing situations. Coaches might be overlooking a vital preparation if they did not prepare some type of cognitive strategy for their runners to use in order to direct their attention away from aversive stimuli.

Unlike the wrestlers in Crossman's (1977) study 12 runners were able to correctly estimate which strategy condition best prolonged their performances. It would be expected that the experienced endurance runners in this study would estimate performance duration more accurately than wrestlers in a maximum endurance run task since it was a more familiar activity to them. The more important implication of this result was that 10 of these 12 subjects ran his/her longest performance duration while employing his/her preferred strategy. Two points need to be re-emphasized here: 1) the preferred strategy may have been more skillfully used, and 2) the task specific strategy produced a greater number of best performances, even though it was least preferred. The possibility existed that the task specific strategy was not preferred because the athletes were not familiar with it. But, the task specific strategy may have been more effective because the subjects who used it successfully, may have concentrated to a greater degree and consequently actually lost track of the duration of their performances. This may have been the case when a subject with a sore leg, unable to decide on whether or not to run the trial, performed for a much longer duration while using the task specific strategy. At the termination of the tests, the same subject indicated that the run had been the worst of all the four performances. This example was one of four instances in which the runners after the experiment found it difficult to believe that they had performed their longest run while using the task specific strategy.

Realizing that there was a time interval of one week between each of the four trials, and that the runners received no objective feedback, observers would be quick to state that it would be difficult for subjects to judge which run was of the longest duration. However, this interpretation was shown to be erroneous in over half the subjects and must be interpreted as part of the ability of an experienced runner to judge performance. The wrestlers in Crossman's (1977) study did not display this ability.

The task specific condition however, seemed to disrupt this ability.

This experimenter suggests again that the true effectiveness of the strategies may have been masked by the subjects' preferences. Given the opportunity to practise and become familiar with all of the strategies, individual success differences that are more striking might emerge.

The reports by the athletes in this experiment indicated that the ability to concentrate on the assigned strategy was high. It is possible that if the coach and athlete, having determined which type of strategy was most appropriate, practised it so that the athlete's ability to concentrate improved, the effect of the strategy might be far greater. Twelve subject's longest runs were coincident with their highest estimate of their ability to concentrate on the assigned strategy.

Walker (1971) suggested that the athlete may be capable of intense concentration which might enable him to tolerate pain and endure longer. Although the runners did report that they experienced pain further research would be needed to clarify the relationship between the ability to concentrate and the degree of pain tolerated.

The runners indicated that they did have to deal with pain in a maximum endurance run and that the perception of the pain generally affected their performance duration. The behaviors of the athletes during their runs were consistent with the characteristics described by Cautela (1977) for experimentally induced pain. Gasping, moaning and exclaiming were common characteristics displayed by the subjects. However, not all of the subjects interpreted their discomfort as painful. In some instances mild discomfort was interpreted as painful while for another runner severe discomfort was not. The longest performance runs were not necessarily described as painful. As Cautela suggested the degree of pain and its interpretation as pain seemed to depend on the subjects' perceptions. The possibility existed that the introduction of a cognitive strategy introduced psychological factors which allowed the subjects to dissociate the pain and continue running.

The information from the athlete's indication of the degree of discomfort and the interpretation of that discomfort as being painful provided for some interesting speculations. The possibility existed that the athlete experienced more than one type of pain. Generalized chronic fatigue and specific soreness of joints and muscles were both reported as painful. Localized pain was not uncommon. It was not uncommon to have an athlete begin the trial complaining of a local pain only to continue and in some cases, perform for his/her best. It was evident that the athletes had to deal with severe chronic fatigue, localized injuries, muscle spasms and in some cases nausea. These examples seemed to be consistent with the statement by Ryan and Kovacic (1966) who suggested that the ability to withstand pain was essential to athletic performance.

The degree of success of the athlete in dealing with pain may have depended upon the athlete's past experience or the effects of the strategy involved, or both. Severe fatigue, localized pain, and even nausea may be experiences which athletes can learn to tolerate. Coaches, it seems, would be well advised to subject their athletes to painful experiences and to teach their athletes how to use cognitive strategies to cope with these phenomena.

The possibility existed that some subjects when assigned a cognitive strategy might assume that it might prolong or restrict performance.

Chaves and Barber (1974) in an attempt to measure this expectancy, reported that expectancy alone did increase the ability to withstand pain. However, Chaves and Barber found that expectancy alone was not as effective as a cognitive strategy. The experimenter attempted to assess this expectancy factor by asking the subjects after each trial if they expected to do better than in their previous trials. It was found that the expectancy to do well or poorly had little relationship to actual performance. Furthermore, it was found that factors other than the assigned cognitive strategies influenced the expectancy of the subject to do well or poorly. Motives for positive and negative expectancies ranged from "I expected to do better, because I felt I did poorly last time" and "I felt that this was a better plan" to "I had a cold" and "My calves were hurting before I started." These statements were made in spite of the fact that the subjects received no information feedback. No relationship of positive or negative expectancy to actual performance was apparent.

The findings of this study are open to various interpretations. But it appears that cognitive strategies may be successful if the subject can skillfully employ the strategy to concentrate and direct attention away from painful stimulation. The cognitive strategy may be successful because it delays the onset of pain or because it allows the subject to endure pain longer.

The type of strategy which is most successful may depend on the individual. Coaches who deal with athletes at many different levels and stages of development should consider experimenting with a variety of different types of strategies. When dealing with elite athletes self-controlled cognitive strategies with relevant task-oriented elements may be superior. Because ultimate success may depend on familiarity with the strategy content, athletes should be allowed to practise the strategies before an assessment is made.

When considering the possibility of using cognitive strategies for other sports the task specific strategy seems to provide the greatest potential. It would seem to be the most beneficial situation if the athletes could concentrate on the maintenance of proper technique in order to direct their thoughts away from noxious stimulations.

Chapter VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This thesis studied the effects of various cognitive strategies on the treadmill running performance of 21 endurance runners from the Athletics North-West Track Club in Thunder Bay.

Each subject practised running for three pretest trials during a one and one-half week period prior to the test trials. Subjects developed a cognitive strategy and then were tested for a maximum run during a consistent time period each week for four weeks. For each run, the runner developed a cognitive strategy and was asked to run until it was impossible to continue. The independent variables were the four cognitive strategy conditions and the dependent variables were the length of performance and the subject's intermittent heart rates.

Posttest and postexperiment questionnaires were administered in order to obtain information regarding the following: a) the amount of discomfort (pain) experienced by the subject, b) the degree and nature of the subject's pretrial expectancy, c) the subject's estimate of the relative length of performance, d) the percentage of time that the subject was able to employ the instructed strategy, e) the subject's preference and estimate of effectiveness of each condition, and f) a description of factors that might have confounded the performance. The research design was balanced in that all possible treatment sequence presentations were randomly assigned an equal number of times.

An ANOVA was performed to indicate if there was a significant difference in performance or heart rate between the four treatments. An a priori orthogonal comparison was used to supplement the ANOVA to compare planned treatments to a controlled condition. A statistical level of .05 was chosen.

Conclusions

A null hypothesis and an a priori hypothesis were presented for this study. The null hypothesis proposed that there was no difference between the treadmill running performances of endurance runners who employed each of four different cognitive strategies. The alternative hypothesis proposed that the running performances of endurance runners increased when a planned cognitive strategy was used as opposed to a condition where no planning was employed.

An ANOVA revealed that there was no significant difference in performance or heart rate between the four treatment conditions. Therefore the null hypothesis was accepted. However, the planned cognitive strategy conditions when taken together produced moderately greater mean performance times as compared to the condition in which the cognitive strategy was not planned. An orthogonal comparison of the mean of the unplanned strategy condition with those of the planned strategy conditions revealed a significant difference. Therefore, the a priori hypothesis was accepted.

Results of the posttest and postexperiment questionnaires revealed several factors. All subjects, except one, preferred the use of planned strategy conditions. Generally subjects performed best under their preferred strategy condition. The strategy condition which was preferred the most was the one in which familiarity played a key role. With the exception of the task specific strategy, subjects showed good ability to estimate which strategy prolonged their performance best. This may indicate that the task specific strategy, which was preferred by only two subjects, might have the best potential for prolonging performance.

Subjects indicated that their ability to concentrate on the content of the assigned strategy was high. They indicated that they did have to deal with pain and that the perception of that pain generally affected their performance duration. The expectation to do well or to do poorly had little relationship to actual performance. Factors other than the assigned strategies influenced this expectancy.

Although most of the endurance runners in this study employed some form of thinking to dissociate themselves from the painful experiences of maximum task demands few probably have a planned method of dealing with these experiences. An individualized planned cognitive strategy is indicated as having the potential to produce a better coping capacity in the athlete.

Recommendations

1. This study should be repeated with certain modifications.

2. Future researchers should consider allowing their subjects to practise the strategies before evaluating their effectiveness.

3. Subjects, from a variety of endurance sports, performing their specific activity should be used to evaluate the universality of the effects of cognitive strategies.

4. Coaches should instruct their athletes in the construction and skillful implementation of cognitive strategies.

5. Coaches should teach technique to their athletes at an early age and then give special attention to the implementation of this knowledge in a cognitive strategy.

6. It is recommended that future research should consider the establishment of a method for determining which type of strategy would be most effective for each athlete.

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APPENDIX A

Tables for twenty-one subjects depicting heart rate compared to performance time for each of the four cognitive strategies and the order of presentation.

Four Strategies

A. Unaided

B. Imagery Manipulation

C. Task Specific

D. Voluntary Distraction

SUBJECT 1

Presentation order ABCD

Time (Minutes)	A	B	C	D
24				
23				180
22				180
21				180
20		180		180
19		180		180
18		180		180
17		180		180
16		180		180
15		180	180	180
14		180	180	182
13	187	180	180	184
12	184	180	180	182
11	184	176	180	184
10	184	176	180	180
9	187	180	180	180
8	180	180	180	180
7	180	180	180	180
6	180	176	173	180
5	176	176	173	176
4	176	176	170	173
3	173	170	170	173

Condition

SUBJECT 2

Presentation order BCDA

Time (Minutes)	A	B	C	D
14				200
13		200		200
12	195	200		200
11	195	200	200	200
10	195	200	200	195
9	195	195	200	195
8	195	195	195	195
7	195	191	195	191
6	191	191	191	191
5	191	187	191	187
4	187	187	187	187
3	184	184	187	180

Condition

SUBJECT 3

Presentation order CDAB

Time (Minutes)	A	B	C	D
14	195			
13	195	191		
12	195	191		
11	191	191		195
10	187	187	200	195
9	184	187	195	195
8	184	187	191	191
7	184	187	187	195
6	184	187	187	191
5	180	184	184	187
4	176	180	180	180
3	173	180	180	173

Condition

SUBJECT 4

Presentation order DABC

Time (Minutes)	A	B	C	D
17		195		
16		195		
15		195		
14	195	195	191	195
13	195	191	191	195
12	195	191	191	195
11	195	191	191	187
10	195	191	191	191
9	195	191	191	191
8	195	191	187	187
7	195	191	187	187
6	195	184	187	187
5	195	184	184	184
4	187	184	184	184
3	187	180	184	184

Condition

SUBJECT 5

Presentation order BCAD

Time (Minutes)	A	B	C	D
13				
12				
11			180	
10			180	
9	180		180	182
8	176		176	180
7	180	180	176	184
6	176	180	176	180
5	176	180	176	176
4	173	180	173	176
3	170	176	173	170

Condition

SUBJECT 6

Presentation order CDBA

Time (Minutes)	A	B	C	D
15				
14			187	
13		187	189	
12	184	187	187	
11	184	184	187	
10	184	187	187	
9	180	184	187	191
8	180	184	187	187
7	180	180	184	187
6	180	180	180	182
5	180	180	180	185
4	176	176	180	180
3	173	173	173	180

Condition

SUBJECT 7

Presentation order DACB

Time (Minutes)	A	B	C	D
10				
9	184		184	182
8	184	184	184	184
7	182	182	180	180
6	184	180	180	180
5	180	176	180	180
4	176	176	176	176
3	173	173	173	167

Condition

SUBJECT 8

Presentation order BACD

Time (Minutes)	A	B	C	D
9				
8	180			173
7	180	180	176	173
6	180	180	176	173
5	176	180	176	173
4	176	176	173	167
3	173	170	173	167

Condition

SUBJECT 9

Presentation order CBDA

Time (Minutes)	A	B	C	D
12				180
11				176
10				176
9				173
8		173	172	173
7	173	173	171	170
6	171	173	170	170
5	169	167	167	170
4	167	164	167	167
3	161	158	164	161

Condition

SUBJECT 10

Presentation order DCAB

Time (Minutes)	A	B	C	D
15			180	187
14			184	187
13			180	187
12			180	187
11			180	180
10		184	180	187
9	180	184	180	187
8	176	184	176	187
7	176	176	176	180
6	176	176	176	180
5	176	176	176	180
4	173	173	173	173
3	173	173	173	173

Condition

SUBJECT 11

Presentation order ADCB

Time (Minutes)	A	B	C	D
15			195	
14		195	195	191
13	200	195	195	191
12	195	195	191	191
11	191	191	191	191
10	187	187	191	187
9	187	191	184	187
8	187	187	184	187
7	180	184	184	187
6	191	184	187	184
5	187	184	184	184
4	187	180	184	180
3	176	180	180	180

Condition

SUBJECT 12

Presentation order CBAD

Time (Minutes)	A	B	C	D
14	184			187
13	184			187
12	184			187
11	180			184
10	180	184	184	184
9	180	182	184	184
8	176	182	184	187
7	180	184	180	184
6	176	180	180	180
5	173	180	180	180
4	173	173	173	173
3	173	173	173	173

Condition

SUBJECT 13

Presentation order DCBA

Time (Minutes)	A	B	C	D
18		171		
17		171		
16		171		
15		167		173
14		167		173
13		167		173
12	167	164		173
11	167	164		173
10	161	161		173
9	161	161	170	170
8	167	161	167	170
7	161	161	167	167
6	161	161	167	167
5	161	158	167	167
4	158	161	161	161
3	158	161	158	161

Condition

SUBJECT 14

Presentation order ACBD

Time (Minutes)	A	B	C	D
17				
16			173	
15			173	173
14			170	173
13			173	173
12			170	170
11	173	173	173	170
10	173	173	167	170
9	173	173	173	170
8	170	170	170	173
7	170	170	167	167
6	170	167	164	167
5	167	167	164	167
4	167	167	164	164
3	164	164	161	164

Condition

SUBJECT 15

Presentation order BDCA

Time (Minutes)	A	B	C	D
15		184		
14	176	184		
13	176	184	180	
12	176	180	180	
11	176	180	180	
10	176	180	180	184
9	180	176	176	184
8	176	176	176	184
7	173	173	173	180
6	173	173	173	180
5	173	170	170	176
4	173	170	173	173
3	173	170	170	173

Condition

SUBJECT 16

Presentation order CADB

Time (Minutes)	A	B	C	D
14			195	
13			195	
12	191		195	195
11	191		191	195
10	191	191	195	195
9	191	191	187	191
8	187	187	187	187
7	187	180	187	187
6	187	180	184	187
5	184	176	184	180
4	184	180	180	180
3	180	173	180	173

Condition

SUBJECT 17

Presentation order DBAC

Time (Minutes)	A	B	C	D
14			173	
13			173	
12		176	173	173
11		176	173	173
10		173	170	173
9	173	173	173	173
8	173	173	170	173
7	173	173	170	170
6	173	164	170	170
5	170	164	167	167
4	170	161	167	167
3	167	161	170	161

Condition

SUBJECT 18

Presentation order ACDB

Time (Minutes)	A	B	C	D
10			184	
9		180	187	184
8	187	180	184	184
7	187	176	182	180
6	182	173	180	180
5	180	176	180	184
4	180	173	180	180
3	180	173	176	176

Condition

SUBJECT 19

Presentation order BDAC

Time (Minutes)	A	B	C	D
15	187			
14	187	180	176	
13	187	180	176	
12	187	180	176	
11	184	180	173	180
10	187	180	173	180
9	180	180	173	180
8	187	173	167	176
7	184	167	167	176
6	176	170	170	173
5	180	167	170	170
4	173	167	167	167
3	173	167	167	167

Condition

SUBJECT 20

Presentation order DBCA

Time (Minutes)	A	B	C	D
14				
13				
12		195		
11		195	200	
10		195	200	
9	195	195	200	200
8	195	191	200	200
7	195	191	200	200
6	191	187	195	195
5	191	187	195	195
4	187	187	191	187
3	187	187	187	187

Condition

SUBJECT 21

Presentation order ABDC

Time (Minutes)	A	B	C	D
15			180	
14			180	
13			180	180
12			180	180
11		184	180	180
10		180	173	173
9	173	180	173	173
8	173	180	170	170
7	173	173	173	170
6	170	170	170	167
5	170	170	167	167
4	170	167	167	167
3	167	164	167	161

Condition

APPENDIX B

1. Performance Time and Heart Rate for Treatments.
2. Performance Time and Heart Rate for Order of Presentations.
3. Performance Time for Order and Treatments for Subgroup of Eight Older and Successful Runners.

PERFORMANCE TIME FOR TREATMENTS

	TREATMENT CONDITIONS			
S's	A	B	C	D
1.	786	1216	965	1419
2.	764	803	658	836
3.	894	790	643	663
4.	846	1010	860	739
5.	548	452	707	650
6.	778	818	840	543
7.	514	533	537	579
8.	482	435	451	533
9.	425	489	534	723
10.	587	642	907	910
11.	776	881	901	886
12.	778	620	625	840
13.	757	1096	598	909
14.	678	706	1012	1002
15.	845	954	805	631
16.	739	654	894	753
17.	598	730	865	761
18.	510	593	633	547
19.	910	828	858	696
20.	538	777	661	548
21.	583	702	912	830

A - unaided condition
B - imagery manipulation condition
C - task specific condition
D - voluntary distraction condition

HEART RATE AT TERMINATION OF PERFORMANCE
(in bpm from the average of the last three recorded readings)

	TREATMENT CONDITIONS			
S's	A	B	C	D
1.	185	180	180	184
2.	195	200	200	200
3.	195	191	196	195
4.	195	195	191	195
5.	179	180	180	184
6.	184	186	188	188
7.	183	182	183	182
8.	180	180	176	173
9.	171	173	171	177
10.	177	184	181	187
11.	195	195	195	191
12.	184	183	184	187
13.	165	171	168	173
14.	173	173	172	173
15.	176	184	180	184
16.	191	190	195	195
17.	173	175	173	173
18.	185	180	185	184
19.	187	180	176	180
20.	195	195	200	200
21.	173	181	180	180

A - unaided condition
B - imagery manipulation condition
C - task specific condition
D - voluntary distraction condition

PERFORMANCE TIME IN ORDER OF PRESENTATION

	ORDER OF PRESENTATION			
S's	1	2	3	4
1.	786	1216	965	1419
2.	803	658	836	764
3.	643	663	894	790
4.	739	846	1010	860
5.	452	707	548	650
6.	840	543	818	778
7.	579	514	537	533
8.	435	482	451	533
9.	534	489	723	425
10.	910	907	587	642
11.	776	886	901	881
12.	625	620	778	840
13.	909	598	1096	757
14.	678	1012	706	1002
15.	954	631	805	845
16.	894	739	753	654
17.	761	730	598	865
18.	510	633	547	593
19.	828	696	910	858
20.	548	777	661	538
21.	912	830	583	702

HEART RATE AT TERMINATION OF PERFORMANCE
(in bpm from the average of the last three recorded readings)

	ORDER OF PRESENTATION			
S's	1	2	3	4
1.	185	180	180	184
2.	200	200	200	195
3.	196	195	195	191
4.	195	195	195	191
5.	180	180	179	184
6.	188	188	186	184
7.	182	183	183	182
8.	180	180	176	173
9.	171	173	177	171
10.	187	181	177	184
11.	195	191	195	195
12.	184	183	184	187
13.	173	168	171	165
14.	173	172	173	173
15.	184	184	180	176
16.	195	191	195	190
17.	173	175	173	173
18.	185	185	184	180
19.	180	180	187	176
20.	200	195	200	195
21.	180	180	173	181

SUBGROUP OF EIGHT OLDER MORE SUCCESSFUL RUNNERS

S's	A	B	C	D
2.	764^4	803^1	658^2	836^3
5.	548^3	452^1	707^2	650^4
9.	425^4	489^2	534^1	723^3
13.	757^4	1096^3	598^2	909^1
14.	678^1	706^3	1012^2	1002^4
15.	845^4	954^1	805^3	631^2
17.	598^3	730^2	865^4	761^1
18.	510^1	593^4	633^2	547^3

A. unaided condition

B. imagery manipulation condition

C. task specific condition

D. voluntary distraction condition

* numbers denote order of presentation.

APPENDIX C

Examples of Posttest Questionnaires

(1) unaided - first trial

(2) unaided - second, third, and fourth trials

(3) strategy - first trial

(4) strategy - second, third, and fourth trials

Example of Postexperiment Questionnaire

POSTTEST QUESTIONNAIRE (1)

Name: ____________________

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO
   b) consume alcohol last night? YES NO
   c) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the degree of discomfort you experienced during your run today.

0	1	2	3	4	5	6	7	8	9	10
No Discomfort		Slight Discomfort		Moderate Discomfort			Severe Discomfort			Very severe Discomfort

3. Would you say your discomfort was painful? YES NO

4. Was there anything preventing you from performing your best today? YES NO

   If answer is "YES" please explain.

5. What were you thinking of during your run today?

POSTTEST QUESTIONNAIRE (2)

Name: ____________________

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO
   b) consume alcohol last night? YES NO
   c) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the degree of discomfort you experienced during your run today.

0	1	2	3	4	5	6	7	8	9	10
No Discomfort		Slight Discomfort		Moderate Discomfort		Severe Discomfort			Very severe Discomfort	

3. Would you say your discomfort was painful? YES NO

4. Did you expect to do better today then on your previous run(s)? YES NO

   Do you feel that you did do better today then on your previous run(s)? YES NO

5. Was there anything preventing you from performing your best today? YES NO

   If answer is "YES" please explain.

6. What were you thinking about during your run today?

POSTTEST QUESTIONNAIRE (3)

Name: ____________________

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO
   b) consume alcohol last night? YES NO
   c) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the % of time you were able to think of the content that you prepared.

0% 25% 50% 75% 100%

3. Rate yourself on the following scale as to the degree of discomfort you experienced during your run today.

0	1	2	3	4	5	6	7	8	9	10
No Discomfort		Slight Discomfort		Moderate Discomfort			Severe Discomfort			Very severe Discomfort

4. Would you say your discomfort was painful? YES NO

5. Was there anything preventing you from performing your best today? YES NO

   If answer is "YES" please explain.

POSTTEST QUESTIONNAIRE (4)

Name: ____________________

Instructions: Please read and circle your response.

1. Did you: a) get enough sleep last night? YES NO
   b) consume alcohol last night? YES NO
   c) eat too much or too little before this trial? YES NO

2. Rate yourself on the following scale as to the % of time you were able to think of the content that you prepared.

   0% ... 25% ... 50% ... 75% ... 100%

3. Rate yourself on the following scale as to the degree of discomfort you experienced during your run today.

   0 1 2 3 4 5 6 7 8 9 10

   No Discomfort (0) — Slight Discomfort (2) — Moderate Discomfort (4) — Severe Discomfort (7) — Very severe Discomfort (10)

4. Would you say your discomfort was painful? YES NO

5. Did you expect to do better today then on your previous run(s)? YES NO

   Do you feel that you did do better today then on your previous(s)? YES NO

6. Was there anything preventing you from performing your best today? YES NO

   If answer is "YES" please explain.

POSTEXPERIMENT QUESTIONNAIRE

Name: ____________________

Instructions: Please answer the following questions carefully. Take some time to think over your answer.

During your last four runs on the treadmill you were asked to think of different things during your run. Although the order of presentation may be incorrect, you were instructed to:

A. Get on the treadmill and run until it was impossible to continue.
B. Imagine that you were taking a scenic run through the countryside and run until it was impossible to continue.
C. Concentrate only on your technique during the run and run until it was impossible to continue.
D. Think about anything that you wanted to during the run and run until it was impossible to continue.

1. Which of the four conditions did you prefer? Why?

2. Which of the four conditions did you feel was the best for prolonging your run?

3. List in order from most effective to least effective the conditions that improved your performance.

   A ( ), B ( ), C ( ), D ( )

4. Write down anything that you feel would be of value for me to know regarding your participation in this experiment.

APPENDIX D

Sample Sheet for Recording

Performance Information.

SAMPLE SHEET FOR RECORDING PERFORMANCE INFORMATION

Name: ____________________

Date: ____________________

Condition: ____________________

Performance Time: ____________

Mean Heart Rate: ____________

Particulars:

Treadmill:

Speed: ____________

Grade: ____________

Date: ____________________

Condition: ____________________

Performance Time: ____________

Mean Heart Rate: ____________

Particulars:

Treadmill:

Speed: ____________

Grade: ____________

Date: ____________________

Condition: ____________________

Performance Time: ____________

Mean Heart Rate: ____________

Particulars:

Treadmill:

Speed: ____________

Grade: ____________

Date: ____________________

Condition: ____________________

Performance Time: ____________

Mean Heart Rate: ____________

Particulars:

Treadmill:

Speed: ____________

Grade: ____________

APPENDIX E

Statements of Auditory Cues for Three Aided Conditions

1. Imagery Manipulation
2. Task Specific
3. Voluntary Distraction

STATEMENTS OF AUDITORY CUES FOR THE IMAGERY MANIPULATION STRATEGY

1. Concentrate.
2. Imagine the beautiful day and beautiful surroundings.
3. Think of the lovely countryside.
4. Think of the enjoyment of running on such a beautiful day.
5. Concentrate on the cool fresh breezes.
6. Listen to the sounds of the countryside.
7. It's invigorating to be running outdoors.
8. See the majestic trees.
9. Feel the cool breeze.
10. Repeat 1 to 9.

STATEMENT OF AUDITORY CUES FOR
TASK SPECIFIC STRATEGY

1. Concentrate.
2. Think about your technique.
3. Relax and concentrate on your style.
4. Keep thinking about your stride length and rhythm.
5. Don't think of anything but technique.
6. Force yourself to concentrate.
7. Think of your head position.
8. Keep thinking about your technique.
9. Start at the top of your list and work your way through.
10. Technique, think about your technique.
11. Repeat 1 to 10.

STATEMENTS OF AUDITORY CUES FOR THE VOLUNTARY DISTRACTION STRATEGY

1. Concentrate on your prepared list.
2. Think of the things that you have prepared.
3. Start from the top of your list and work your way through.
4. If you wish you may repeat your items out loud.
5. Concentrate on your preparations.
6. Go over and over the items on your list.
7. Concentrate on your favorite item.
8. Remember to concentrate on your list.
9. Think of nothing but the items on your list.
10. Repeat 1 to 9.

APPENDIX F

Example Phrases and Words for the Imagery Manipulation Strategy

Example Phrases and Words for the Task Specific Strategy

APPENDIX F

Example Phrases and Words for the Imagery Manipulation Strategy

free as a bird

cool fresh breeze

enjoyment of running

invigorating

majestic trees

Example Phrases and Words for the Task Specific Strategy

head still

eyes

arms

hands

stride length

rhythm

APPENDIX G

Table of Performance Time in Seconds for Baseline Trials
With Appropriate Treadmill Speed and Grade Denoted.

TABLE OF PERFORMANCE TIME IN SECONDS FOR BASELINE TRIALS WITH APPROPRIATE TREADMILL SPEED AND GRADE DENOTED

SUBJECT	BASELINE TRIAL	TIME	SPEED	GRADE
1	1	480	9.5	3
	2	1000	9.25	3
	3	673	9.5	3*
2	1	500	11.5	4
	2	581	11.5	4
	3	672	11.5	4*
3	1	560	11.0	3
	2	816	11.0	3
	3	597	11.25	3*
4	1	815	9.0	3
	2	793	9.25	3*
	3	406	9.5	3
5	1	450	11.0	3
	2	467	11.0	3*
	3	275	11.0	3+
6	1	386	10.0	3
	2	501	10.0	3
	3	555	10.0	3*
7	1	665	8.0	3
	2	438	8.75	3
	3	510	8.5	3*
8	1	793	9.0	3
	2	455	9.25	3
	3	505	9.25	3*
9	1	840	11.0	4
	2	502	11.5	4
	3	481	11.5	4*
10	1	1041	8.25	3
	2	668	8.75	3
	3	739	9.0	3*
11	1	970	9.25	3
	2	665	9.75	3*
	3	646	9.75	3
12	1	674	9.0	3
	2	870	9.25	3
	3	495	9.5	3*
13	1	405	11.0	3
	2	845	10.75	3
	3	780	11.0	3*
14	1	368	11.0	3
	2	613	10.5	3
	3	550	10.75	3*
15	1	798	10.5	3
	2	423	11.0	3
	3	623	10.75	3*
16	1	240	11.0	3
	2	1201	10.5	3
	3	763	11.0	3*
17	1	563	11.0	3
	2	759	11.0	3
	3	649	11.25	3*
18	1	285	11.5	4
	2	546	11.0	4
	3	489	11.0	4*
19	1	1115	9.0	3
	2	755	10.0	3
	3	876	10.0	3*
20	1	635	9.0	3
	2	491	9.25	3*
	3	416	9.25	3
21	1	581	10.0	3
	2	583	10.25	3
	3	481	10.5	3*
22	1	465	9.0	3
	2	840	9.0	3
	3	445	9.25	3*
23	1	616	10.5	3
	2	615	10.5	3
	3	650	10.5	3*
24	1	407	11.0	4
	2	348	11.0	4
	3	574	10.5	4*

* Experimental Task Speed and Grade

+ Injury