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Effects of cognitive strategies on the performance of athletes

Crossman, Jane E.

THE EFFECTS OF COGNITIVE STRATEGIES ON THE PERFORMANCE OF ATHLETES

BY: JANE CROSSMAN

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THE EFFECTS OF COGNITIVE STRATEGIES ON THE PERFORMANCE OF ATHLETES

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Jane Crossman

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ABSTRACT

The purpose of this thesis was to study the effects of various cognitive strategies on the treadmill running performance of intercollegiate wrestlers (N=12). The independent variables were the four cognitive strategies presented to each S. The dependent variables were the length of time each S would perform at constant effort and intermittent heart rates during performance. Three independent replications of a 4 X 4 latin square were utilized. An analysis of variance revealed no significant difference in performance or heart rate between the four treatments ($p > .05$). The Ss for both performance and heart rate scores revealed a significant F ratio ($p < .05$). Eleven Ss ran their best under a directed situation (either voluntary distraction, imagery manipulation, or task specific). One S ran his best under the unaided condition. On a post-experiment questionnaire, Ss displayed a lack of awareness of the condition which maximized their performance.

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TABLE OF CONTENTS

LIST OF TABLES

Chapter I

INTRODUCTION

Statement of the Problem

The purpose of this thesis was to study the effects of various cognitive strategies on the performance of athletes in training on a non-specific task.

Significance of the Study

Sport coaches are constantly seeking new methods to improve athletic performance. There is an increasing awareness of the importance of psychological preparation for affecting optimal performance. A clarification of some of the important psychological variables associated with performance would be an important contribution to the coaching profession.

One feature which limits human athletic performance is the generalized discomfort associated with fatigue. Several studies have attempted to increase pain tolerance through the application of various cognitive strategies.

This thesis compared four cognitive strategies for their effect on a maximum endurance task. The four conditions involve several popular forms of distraction that are discussed in the literature. It has been proposed that one specific form of cognition during endurance tasks enhances endurance performance. That method was compared with three other forms of cognitive distraction.

The comparison of a variety of strategies is unique. Other researchers, at best, have compared only two treatment conditions in the area of pain tolerance. Those studies have involved the application of specific pain for a short duration e.g. pain stimulator on finger for two minutes (Chaves and Barber, 1974), or cold immersion for four minutes maximum exposure (Blitz and Dinnerstein, 1971). There is a lack of research concerning the application of cognitive strategies to increase tolerance for general discomfort e.g. the discomfort of lactic acidosis of a six minute all-out run. This study also indulges the investigator's scientific curiousity about the topic.

Delimitations

This thesis was delimited to the study of the performance of intercollegiate wrestlers on the specific task of treadmill running. The possibility that the subjects might have discontinued school or wrestling or have gotten injured during the study existed. The wrestling abilities of the subjects ranged from the novice to the Olympic calibre athlete.

The independent variables for the study were the four cognitive strategies presented to each subject: unaided, task specific, imagery manipulation, and voluntary distraction. The independent variables were selected on the basis of their 1) past success in increasing pain tolerance, 2) potential application in sport settings, 3) explicit methodology, and 4) uniqueness from one another. The strategies in this study cover a wide variety of possibilities for application.

The dependent variables were the length of time each subject could perform at constant effort and intermittent heart rates during performance.

Limitations

1. The study was limited to the performance of 12 conveniently selected intercollegiate wrestlers.

2. This study was based on the assumptions that 1) the subjects were representative of intercollegiate wrestlers, 2) they performed each condition as instructed, 3) they were capable of concentrating on and understanding the procedures involved in each cognitive strategy, 4) the cognitive strategies used under the experimental conditions had a carry-over effect to other physical activities, 5) the factors controlling fatigue were equal to those controlling specific pain, and 6) an alpha level of .05 was set for statistical significance.

Definitions

Cognitive strategy refers to a consistent form of thinking during an activity.

Maximum effort is work done at the highest possible magnitude or quantity.

Pain tolerance in this study is the duration of time spent running on a treadmill. Pain tolerance is usually measured by the total elapsed time from beginning of stimulation until the subject withdraws from stimulation.

Heart rate is the number of ventricular contractions per minute determined from the readings of an electrocardiogram.

Intercollegiate wrestlers are men aged 18 to approximately 23 years who train with their university team and compete against each other and against wrestlers from other universities.

Their abilities range from the novice to Olympic calibre athlete.

Unaided Cognitive Strategy: Performance with no specific instructions.

Task Specific Cognitive Strategy: Altering or transforming the experience of pain or discomfort by concentrating on technique and cue words that are associated with the performance task.

Imagery Manipulation Cognitive Strategy: Changing the experience of pain by participating in fantasy.

Voluntary Distraction Cognitive Strategy: Implementing a self-chosen strategy covering numerous possibilities to alter pain perception e.g. singing, adding numbers.

Chapter II

REVIEW OF LITERATURE

Although cognitive strategies have been used effectively in the control of specific, short duration pain, they have virtually been neglected in the control of general discomfort. In the search for new approaches to the control of pain and discomfort, research is being directed towards the cognitive processes. For discomfort states which cannot be brought under the control of anaesthetics or other techniques, psychological procedures are of particular importance (Melzack, Weisz, and Sprague, 1963).

Several studies have attempted to increase pain tolerance through the application of various cognitive strategies. Chaves and Barber (1974) indicated that a variety of psychological techniques including imagery manipulation and distraction (counting and adding aloud), were effective in attenuating localized, short duration pain (finger pressure and cold immersion). Barber and Cooper (1972) concluded from their research that distractions such as story telling may be effective in reducing pain if the pain-stimulator is applied for one minute or less. However, if stimulation exceeds one minute, distraction appears to be ineffective. Blitz and Dinnerstein (1971) found that pain threshold could be significantly elevated by imagery manipulation and by concentrating on the cold (pain stimulus). The latter was reported as being more effective while pain tolerance was not significantly increased by either cognitive strategy. Spanos and Horton (1975) found that cognitive strategies increased the pain threshold of subjects who showed a high pre-test pain threshold. No alteration of pain thresholds was found for subjects with a low pre-test pain threshold. Relevant strategy, which is imagining a thought inconsistent with the painful stimulus while being subjected to it e.g. concentrating on a hot, dry day while hand is in cold water, proved more effective in increasing pain threshold than irrelevant strategy (concentrating on an experience unrelated to the painful stimulus while being subjected to it). Kanfer and Goldfoot (1966) investigated several behaviors as potential self-controlling devices for pain tolerance. They found external stimulation (watching a clock and looking at slides) more effective than verbal devices (describing sensations).

Two studies compared the effects of permissive and non-permissive instructions upon pain threshold and pain tolerance (Blitz and Dinnerstein, 1968; and Wolff, Krasnegor, and Farr, 1965). The latter study concluded that both permissive and non-permissive instructions had no effect on pain threshold but pain tolerance was higher for subjects receiving non-permissive instructions. These results suggest that pain threshold and pain tolerance have different loadings of physiological and psychological components. Blitz and Dinnerstein however, found that appropriate instructions regarding the quit point increased both pain threshold and pain tolerance.

Several studies have shown significant correlations between pain threshold and pain tolerance (Brown, Fader, and Barber, 1973; Clarke and Bindra, 1956; and Davidson and McDougall, 1969). These studies also suggest that there is a general pain responsitivity between various pain-producing stimuli e.g. cold immersion, finger pressor, and shock.

All studies mentioned so far have involved the application of shock, cold immersion, or finger pressure for a short duration on a specific area e.g. hand.

Two studies investigated pain tolerance and athletic participation. Ryan and Kovacic (1966) found contact athletes have a higher pain tolerance than non-contact athletes when measured by cleat pressure against the leg and by a pressure cuff on the arm. There was no significant difference in pain threshold levels between the two groups. Walker (1971) investigated pain and distraction using athletes and non-athletes. The athletes, selected on the basis of their participation on the varsity basketball team, demonstrated a higher pain tolerance than non-athletes. Neuromuscular skill measured by a Hole-type Steadiness Test was adversely affected for both groups. Walker found distraction, being the administration of the steadiness test, failed to raise tolerance to the pain stimulator (electrical stimulation). This is contradictory to the results of other studies (Kanfer and Goldfoot, 1966; Melzack, Weisz, and Sprague, 1963). Perhaps the discrepancy was due to the inappropriate pain stimulator used in the study. Pain increases too sharply with electrical stimulation and thus, does not allow sufficient time for distraction to be effective.

Only one article mentioned cognitive strategies for coping with the prolonged discomfort of running hard (Moore, 1976). The article, with its limited scientific validity, hinted at the possibility of using cognitive strategies to dissociate or distract the pain associated with a distance run. Cognitive strategies such as imagining building houses, humming symphonies, and playing the role of a locomotive are mentioned as devices marathon runners use to prolong the discomfort of running hard.

The above review of literature is associated with specific pain. It should be understood that the discomfort which accompanies endurance fatigue e.g. the agony of lactic acidosis, is general. In light of the absence of research associated with tolerating general discomfort, the analogy is drawn between the parameters affecting specific pain are those affecting general discomfort.

Chaves and Barber (1974) suggested that subjects may implement cognitive processes to reduce discomfort and pain in control or unaided treatments of pain studies. Cognitive strategies require subjects to concentrate on thoughts that are inconsistent with the experience of discomfort. It is possible that any reduction in discomfort that is achieved using a cognitive strategy will reduce discomfort and improve performance. Chaves and Barber (1974) concluded that when subjects were not provided with cognitive strategies but were led to expect a reduction in pain, pain was significantly reduced compared to the control treatments.

The literature suggests then that persons may already invoke distraction strategies without prompting from an external source when in pain tolerance situations. Some form of in-task thinking or reappraisal of the task situation appears to increase tolerance to localized pain. No scientific research has been conducted concerning the tolerance of general discomfort, particularily that associated with athletic performance.

An improvement in performance using one or more cognitive strategies would make a significant contribution in this area of psychology and more specifically to its practical application in coaching.

Chapter III

GENERAL METHODS AND PROCEDURES

Hypothesis

There is no difference between the treadmill running performance of subjects using each of four in-task cognitive strategies.

Subjects and Setting

The subjects were 12 intercollegiate wrestlers of the Lakehead University Wrestling Club. The experiment was conducted in the physiology laboratory in the C.J. Sanders Fieldhouse of Lakehead University.

Apparatus

The treadmill used in this experiment (Quinton Instruments) can be set at speeds from 0 to 15 miles per hour and with grades from 0 to 40 degrees. A telemetry system (Quinton Instruments) was attached to the subject before each run. A biolink receiver recorded the heart rate as monitored on a Cambridge VS4 unit. Subjects listened to one of four tapes played on a cassette recorder before each run and wrote down cue words or statements (if necessary) on large 24" X 32" sheets of paper. Two Heurer trackmaster stopwatches clocked performance time.

Research Design

In this experiment three independent replications of a 4 X 4 latin square were utilized to statistically verify that any improvements in performance were due to the treatments. In a latin square design each condition occurs once in each row and each column. The order of presentation of treatments for the three latin squares was randomly selected by a table of random numbers. An arrangement of this kind assures that no two subjects in each latin square have the same order of presentation of the four conditions. Subjects were randomly assigned to each square and then to each treatment sequence.

Independent and Dependent Variables

The independent variables (the four conditions) were chosen on the basis of their 1) past success in increasing pain tolerance, 2) potential practical application in sport settings, 3) explicit methodology for implementation, and uniqueness from each other.

The unaided condition required that the subject get on the treadmill and run until it was impossible to continue. The second condition, voluntary distraction, allowed the subject to think of anything he wished during the run. Task specific, the third condition, required that the subject think only of his technique during the run e.g. rhythm, stride length. The fourth and final condition, imagery manipulation required the subject to imagine running through a scenic countryside.

The major dependent variable, performance time, recorded in seconds, was selected because it isolated the effects (if any) the cognitive strategies had on performance. A second dependent variable, heart rate, was calculated as the mean of the last three heart rates of each trial. After each run a posttest questionnaire (see Appendix B) was answered to determine the subject's impressions of the trial and isolate any factor(s) that might have hindered performance during the run.

Controls

Various controls were implemented to support the credibility of the experiment. Subjects ran the same day each week at the same time whenever possible. Subjects were asked to get enogh sleep and not to drink alcohol the night before the trial. In addition, they were asked not to eat too much or too little food before the trial. During the experiment no performance information was given to the subject. Each subject ran at a speed and incline suited to his physical capabilities and this speed and grade were consistent for all four trials.

Interaction during the trial was minimized by the use of a cassette recorder to transmit instructions. Each of the four treatments were replicated exactly across subjects by the use of a cassette recorder and standardized procedures. Random selection of factors such as subjects, conditions, order of presentation of conditions etc. were undertaken as essential control procedures.

Analysis of Data

Data were analyzed using a latin square design (Edwards, 1950) to determine whether a significant difference in performance or heart rate existed between the four independent variables.

Performance improvement was determined by averaging the performance durations for each condition. The least condition was used as the standard for determining the percent improvement of the other three conditions.

Responses on the postexperiment questionnaire (see Appendix C) were used as an index to determine whether subjects were correct in their assessment of which condition was most effective in prolonging their performance.

An alpha level of .05 was set for statistical significance.

Stages of the Study

Subject Selection

Potential subjects were initially selected on the basis of their availability, interest, and suitability for the study as previously defined. After the initial screening, 12 wrestlers were randomly selected to serve as subjects for the experiment.

Baseline

Each subject was required to run up to four times on the treadmill before the experimental conditions were implemented. The purposes of these initial runs were 1) to teach the subject how to get on and off the treadmill, 2) to adapt the subject to the running motion of the treadmill and to the telemetry attachments, 3) to establish the speed and grade best suited to the physical capabilities of each subject, and 4) to attempt to stabilize performance so performance improvement due to extraneous rather than independent variables is minimized.

For the baseline trials the subject entered the laboratory and was attached to the telemetry. He was then instructed to run on the treadmill until it was absolutely impossible to continue. Based upon performance time, the speed and grade for each subject was arrived at by systematic trial and error (depending upon adaptation and stabilization rate). Ideally the speed and grade chosen for each subject aimed at a performance time of 10 to 12 minutes during the final baseline trial. Performance time, treadmill speed and grade and any particulars that might effect the results were recorded on a standardized sheet. Heart rate was monitored at the following increments: before the treadmill was turned on, just as the stopwatches were started at 30, 60, 90 seconds and every minute henceforth e.g. 2, 3, 4, ...

For every run (baseline and experimental) the subject mounted and began walking on the treadmill that was moving at 1.5 miles per hour at a two percent grade. The speed was constantly increased until the desired speed was reached. The speed and incline of the treadmill was periodically calibrated for consistency throughout the experiment. Because subjects were given a warm-up before they reached their task speed and grade, the amount of time to increase the speed of the treadmill was calibrated and found consistent throughout the experiment.

Experimental

The experimental procedures were replicated across subjects and treatments. Two persons were present in the laboratory during the trials, each having specific functions. After the subject entered the laboratory he was asked to sit down and listen to one of four tapes on a cassette recorder. The instructions were as follows:

Unaided - After the treadmill is turned on get up on it and straddle the sides of the running surface. Grab the bars at the side and start walking. When you are comfortably striding let go of the bars. I'd like you to run on the treadmill until it is absolutely impossible to continue. When you grab the bars at the side of the treadmill I'll know it is impossible for you to continue running.

Voluntary Distraction - For this run I'd like you to think of anything you wish. You may sing, count or think of anything you'd like. Plan what you are going to think of. You may write down words or statements that will help you to think of the things you want to. I'd like you to run until it is absolutely impossible for you to continue. Signal to me when you can run no longer.

Task Specific - For this run I'd like you to focus your attention and concentrate only on your technique. During the run you are to think of nothing else. Concentrate on your rhythm making sure it is as even as possible. Focus on your stride length making it consistent. Keep your head still. As the run continues make sure your arms are relaxed. Remember you are to think only about your technique, concentrating on rhythm, stride length, hand and head position etc.

Now write down words or statements that will help you focus your attention solely on your technique. Some examples to get you started are written on a sheet of paper in front of you. After you have written down words or statements that you can refer to, study and learn them before you get on the treadmill. I'll put the words and statements on the wall in front of the treadmill so you can refer to them during the run. When you feel you have digested the words and statements you are going to refer to, get on the treadmill. I'd like you to run until it is absolutely impossible to continue. Signal to me when you can run no longer.

Imagery Manipulation - For this run I'd like you only to imagine that you are outside running in the countryside. During the run you are to think of nothing else. Focus your attention on the scenery. Think only of the beauty of the trees, the freedom of running and the invigoration of the fresh air. As you continue running you should realize how much you are enjoying the run and how much you are appreciating the beautiful surroundings.

Now write down words or statements that will help you focus your attention solely on the imagined scenic run. Some examples to get you started are written on a sheet of paper in front of you. After you have written down words or statements that you can refer to, study and learn them before you get on the treadmill. I'll put the words and statements on the wall in front of the treadmill so you can refer to them during the run. When you feel you have digested the words and statements you are going to refer to, get on the treadmill. I'd l'd like you to run until it is absolutely impossible to continue. Signal to me when you can run no longer.

The subject having taken as much time as necessary to plan, learn, and remember what he was going to think of during the run was then prepared for the trial by the laboratory assistant. Blood pressure and chosen words and statements were recorded. As previously instructed, the subject mounted the treadmill and began walking. As the task speed and grade were reached and the subject was running without holding onto the bars, the stopwatches were started and the heart rate recorded. At the third minute and every minute henceforth the laboratory assistant went to the front of the treadmill and instructed the subject for a period of five seconds, to keep concentrating on what he was asked to think of e.g. countryside run, technique etc. Statements such as "don't let your mind wander"; "think about you stride length, making it consistent" are examples of statements effective in making sure the subject was thinking of exactly what was asked of him. The unaided condition required no cueing.

When the subject grabbed the bars at the side of the treadmill and straddled the sides of the running surface indicating he could run no longer, the stopwatches were stopped. The speed of the treadmill was decreased to about two miles per hour to allow the subject to recover actively. Performance time was then recorded and heart rates monitored on the E.C.G. paper were kept for future reference. Finally the subject was asked to complete the posttest questionnaire before leaving the laboratory. After the final trial the subject was thanked and paid for his participation in the experiment and asked to fill out the postexperiment questionnaire and return it when complete. Performance information was given in confidence to the subject upon completion of the postexperiment questionnaire.

Chapter IV

RESULTS

Two treatments, voluntary distraction and imagery manipulation produced overall performance times which were 12.7% better than the unaided condition while the task specific condition produced performance times which overall were 9.6% better (see Table 1 for basic statistics). Heart rate scores remained relatively the same for all four treatment conditions (see Table 2).

Table 1

Maximum, Minimum, and Average Performance Times in Seconds for Each of the Treatment Conditions

Statistic	TREATMENT CONDITIONS			
	Unaided	Voluntary Distraction	Imagery Manipulation	Task Specific
Maximum	973	1140	999	1382
Minimum	453	520	526	457
Average	663.58	748.25	748.25	734.25
Standard Deviation	145.45	191.87	167.72	226.79

Table 2

Maximum, Minimum, and Average Heart Rates for Each of the Treatment Conditions

Statistic	TREATMENT CONDITIONS			
	Unaided	Voluntary Distraction	Imagery Manipulation	Task Specific
Maximum	188	192	195	196
Minimum	162	160	161	162
Average	176.17	176.34	175.92	177.42
Standard Deviation	7.53	9.51	9.71	10.36

The majority of subjects (N=11) ran their best performances under a directed situation (either voluntary distraction, imagery manipulation, or task specific) (see Table 3). Only one subject ran his best trial under the unaided condition. Furthermore, 7 subjects ran their poorest trial under the unaided condition.

Table 3

Frequencies With Which the Various Conditions Based on the Subjects' Running Performance Times Were Ranked

Rank	TREATMENT CONDITIONS			
	Unaided	Voluntary Distraction	Imagery Manipulation	Task Specific
first	1	4	3	4
second	3	2	5	2
third	1	4	3	4
fourth	7	2	1	2

The results of the study and appropriate partitioning of sums of squares for performance durations are present in Table 4 and for heart rates in Table 5. No significant difference in performance time existed between the four treatment conditions. Assuming heart rate to be an index of constant work, no significant difference in heart rate existed between the four treatments, indicating that each subject worked similarily in all four conditions. In fact heart rate was very stable for each subject, showing an initial increase up to the same asymptote on every trial (see Appendix A). Therefore, on the basis of these results the null hypothesis is accepted. The between subjects source of variance for both performance times and heart rate scores revealed a significant F ratio.

Table 4

Latin Square Analysis
for Performance Time

Source	SS	df	MS	F
Treatments	59,913.25	3	19,971.09	1.29
Order	60,851.50	3	20,283.83	1.31
Subjects	1.125.372.00	11	102,306.55	6.6247[a]
Residual	463,295.75	30	15,443.19	
Total	1,709,432.5	47		

[a]Significant at .05

Table 5

Latin Square Analysis
for Heart Rate

Source	SS	df	MS	F
Treatments	11.7	3	3.9	
Order	49.4	3	16.5	
Subjects	3651.50	11	331.96	24.09[a]
Residual	413.30	30	13.78	
Total	4125.9	47		

[a]Significant at .05

Chapter V

DISCUSSION

A postexperiment questionnaire given to subjects after their final trial asked them to indicate which treatment was most effective in prolonging their performance. The responses showed definite preferences for conditions. Not one subject indicated that he felt the unaided condition was most effective in prolonging his performance. However, no directed condition was particularly prefered over any of the others. Interestingly, subjects displayed a lack of awareness concerning which condition they felt maximized their performance. Nine subjects (75%) were incorrect in their assessment of which condition prolonged their run the most. These findings suggest that the possibility exists that coaches could be making an error in letting their athletes decide what to think about during performance. For example, if an athlete felt that an imagery manipulation cognitive strategy was most effective in prolonging performance when task specific was in fact the most effective, the athlete would be making an incorrect assessment that could interfere with the achievement of an optimal performance. Therefore, there needs to be some assessment method developed to discover which is the most beneficial cognitive strategy for each athlete to implement.

In the experiment subjects ran at various workloads and for varying durations on the treadmill, suggesting a difference between their physical capabilities. Each subject however ran at a constant speed and grade for all four trials. To some, this difference and inconsistency may be cause for concern. This problem was alleviated by using the latin square form of analysis. In that analysis, subject differences are partitioned and dispersed across treatments so that their effect on the decisions made from the analysis are minimal.

Another possibility existed that subjects could have learned from the successive presentation of trials on the treadmill e.g. there may have been a training (learning) effect. This possibility was analysed in both the analyses for performance and heart rates. The non-significant F ratio in performance indicated that sequential effects of the trials did not exist. This was further substantiated in the heart rate analyses where order effects were not evidenced. Indeed, if there had been a training effect one would expect an alteration in heart rate because it is an index of training. However, that was not evidenced.

The absence of feedback about performance time may have influenced the results. The possibility existed that some subjects may have performed better and others poorer if they had been given performance information after each trial. The aim of the study was not to produce successive improvements in performance. Rather, the denial of performance information was a control to avoid goal setting in each performance which might have obscured any differences in treatments which were applied. The baseline conditions that were established were done in the absence of performance information. They demonstrated that this procedure produced consistent performances.

Further substantiation of this point was brought out by the non-order effect. Thus, it can be concluded that variations in performance were due to factors other than an absence of performance information. However, this is a potential variable for manipulation and so, further investigations in this field should consider its presence and possible effects.

The results revealed there was no significant difference in heart rate between the four treatment conditions indicating consistency across trials. Heart rate, an index of constant performance, remained stable near the end of every experimental trial even though the duration of the trials varied greatly. Perhaps some variable other than a physiological one was present to explain the differences in mean performance times from condition to condition. The possibility exists that the variable accounting for the fluctuation between treatments could have been the cognitive strategies presented to each subject.

The lack of statistical difference between the four conditions in performance might have been due to the non-specific nature of the task. Wrestlers are trained for their particular sport and not for running. The subjects in this study were not doing the activity they were most familiar with. Their knowledge of running technique was likely to be inferior to that of the trained runner and so the real effect of the task specific condition may have been obscured.

There are a number of possible solutions to this problem. It may be a valuable procedure alteration to allow each subject to have a constant number of practice trials in each condition before assessing a criterion trial. This may facilitate better utilization of the strategies and consequently their effects may be better revealed. In this study it was assumed that cueing was a substitute for learning. The possibility exists however that cueing may be inferior to actual learned cognitions.

The baseline trials for some subjects showed instability over a number of trials (see Appendix H). Subject GK for example, varied as much as three minutes between his second and third trials even though he was running at the same speed and grade. Subject NC ran three trials at the same speed and grade and fluctuated 7 minutes between the best and worst runs. Some subjects however, e.g. KD, had relatively stable baseline trials, showing consistency in performance. This was a design weakness as the variability within subjects may have inflated the error estimate to the extent that true effects were observed. There are a number of factors which could account for this instability.

Again, subjects in this thesis were not doing the activity with which they were most familiar. It is likely that a trained runner would show consistency in performance across numerous trials because of repeated exposure to and familiarity with the task. The wrestlers showed vast fluctuation from day to day on the running task. It is possible that the baseline would not have stabilized even if the study was replicated using the same subjects performing the same task. In future studies of this nature using an intrasubject design, the baseline must be stabilized before the experimental trials begin. Sidman (1960) stated that intrasubject replication can occur only when the baseline "has attained a steady, recoverable state, or when the baseline is changing in some known, orderly fashion." Therefore, baseline trials are necessary for subjects until a stable baseline is achieved. The number of baseline trials necessary to attain stabilization will vary from subject to subject.

To attain a stable baseline in future studies, it may be necessary to control for more factors than demonstrated in this investigation. Diet, sleep, and training load are examples of factors that may have to be controlled if the true effects of the treatments are to surface.

Subjects in future studies should be élite and very familiar with the performance task. Moore (1976) in his article "Watching Their Steps", cites various examples of élite runners who use cognitive strategies to dissociate the pain of a marathon run. Using subjects in future studies of this nature that are not élite may result in a lack of clarification concerning the potential of the task specific condition for affecting improved élite performance.

To date, no research has been conducted concerning the specificity and non-specificity of cognitive strategies with regard to classical pain tolerance. Moore (1976) suggested that the application of cognitive strategies must be specific to each athlete if improved performance is to result. For example, one athlete may perform consistently better using a particular cognitive strategy e.g. imagery manipulation, while another athlete may perform consistently better using a different cognitive strategy e.g. task specific. The results of this thesis seem to suggest that indeed the success of cognitive strategies in improving athletic performance depends upon their specific application. It should therefore be imperative to establish the cognitive strategy which maximizes performance for each athlete prior to experimental or practical application.

Perhaps replicating the experiment using an intrasubject design and élite athletes on a familiar task (trained runners running or swimmers swimming) would clarify the effectiveness of each treatment and guarantee optimal strategy usage. Intersubject replication, using subjects from a variety of sports performing their specific activity (one swimmer swimming, one runner running, one wrestler wrestling etc.) is also another possibility for a future research design.

The possibility exists that specific pain is not analogous to general discomfort. Lack of research concerning this distinction forced an assumption that may have been too presumptuous. A number of research procedures have been considered in this discussion which would suggest modifications in the design and investigation of this topic. Perhaps they would lead to a better understanding of this assumption.

Chapter VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This thesis studied the effects of various cognitive strategies on the treadmill running performance of athletes in training. The subjects were 12 intercollegiate wrestlers from Lakehead University.

Each subject ran up to four times on the treadmill before the experimental conditions were implemented for adaptation purposes. For the experimental trials subjects were given four different cognitive strategies (consistent forms of thinking), one strategy per trial. The independent variables were the four cognitive strategies presented to each subject and the dependent variables were how long each subject could run on the treadmill at constant effort and intermittent heart rates during performance.

Three independent replications of a 4 X 4 latin square were utilized. No two subjects in each latin square had the same order of presentation of the four conditions. A latin square analysis was used to determine whether a significant difference in performance or heart rate existed between the four independent variables. An alpha level of .05 was set for statistical significance. No significant difference between treatments was evidenced.

Conclusions

The hypothesis proposed that there was no difference between the treadmill running performance of subjects using each of four in-task cognitive strategies.

The results revealed that there was no significant difference in performance or heart rate between the four treatments. Mean performance times were slightly longer under each of the three directed conditions than under the unaided condition, but the difference did not reach significance. Subjects displayed a lack of awareness on the postexperiment questionnaire concerning which condition they felt maximized their run.

The lack of statistical difference between the four conditions in performance may have been due to the non-specific nature of the task. The fluctuation in performance from condition to condition suggested an inconsistency in performance due to lack of specific training for the running task. Therefore, the null hypothesis was accepted on the basis of the results.

Recommendations

1. It is recommended that subjects in future research be élite and performing the activity they are most familiar with.

2. Intersubject replication of an intrasubject design, where subjects from a variety of sports perform their specific activity should be used to further clarify the effectiveness of each treatment and guarantee optimal strategy usage.

3. In designing research of this nature it is necessary to select a dependent variable that varies minimally in baseline conditions.

Replication of this thesis implementing the above suggestions would likely clarify the effectiveness of each treatment thereby making a valuable contribution to the coaching profession.

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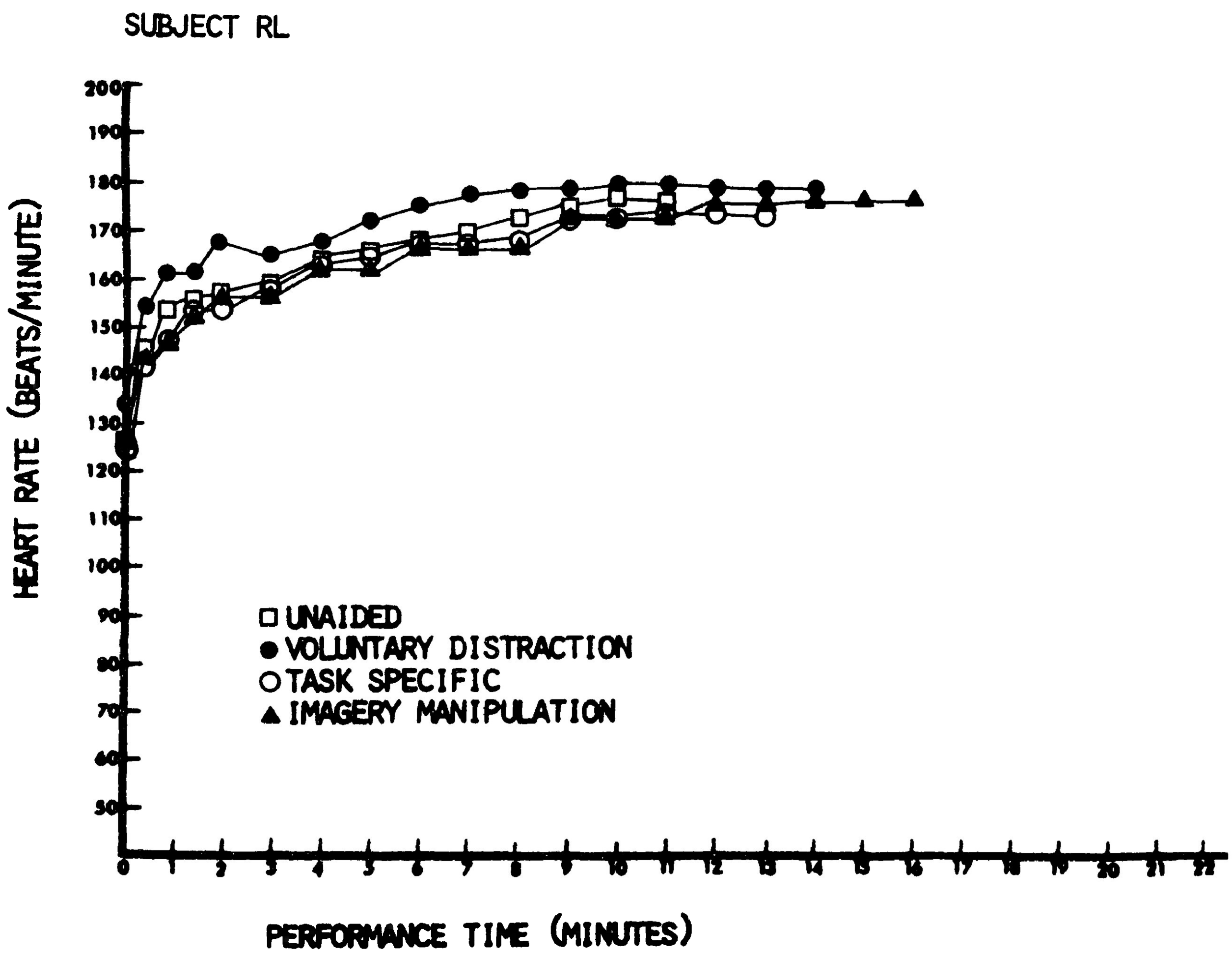
APPENDIX A

Twelve Graphs, One for Each Subject,
Showing Heart Rates for Each of
the Four Cognitive Strategies


SUBJECT RL
HEART RATE (BEATS/MINUTE)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
0
1
2
3
4
5
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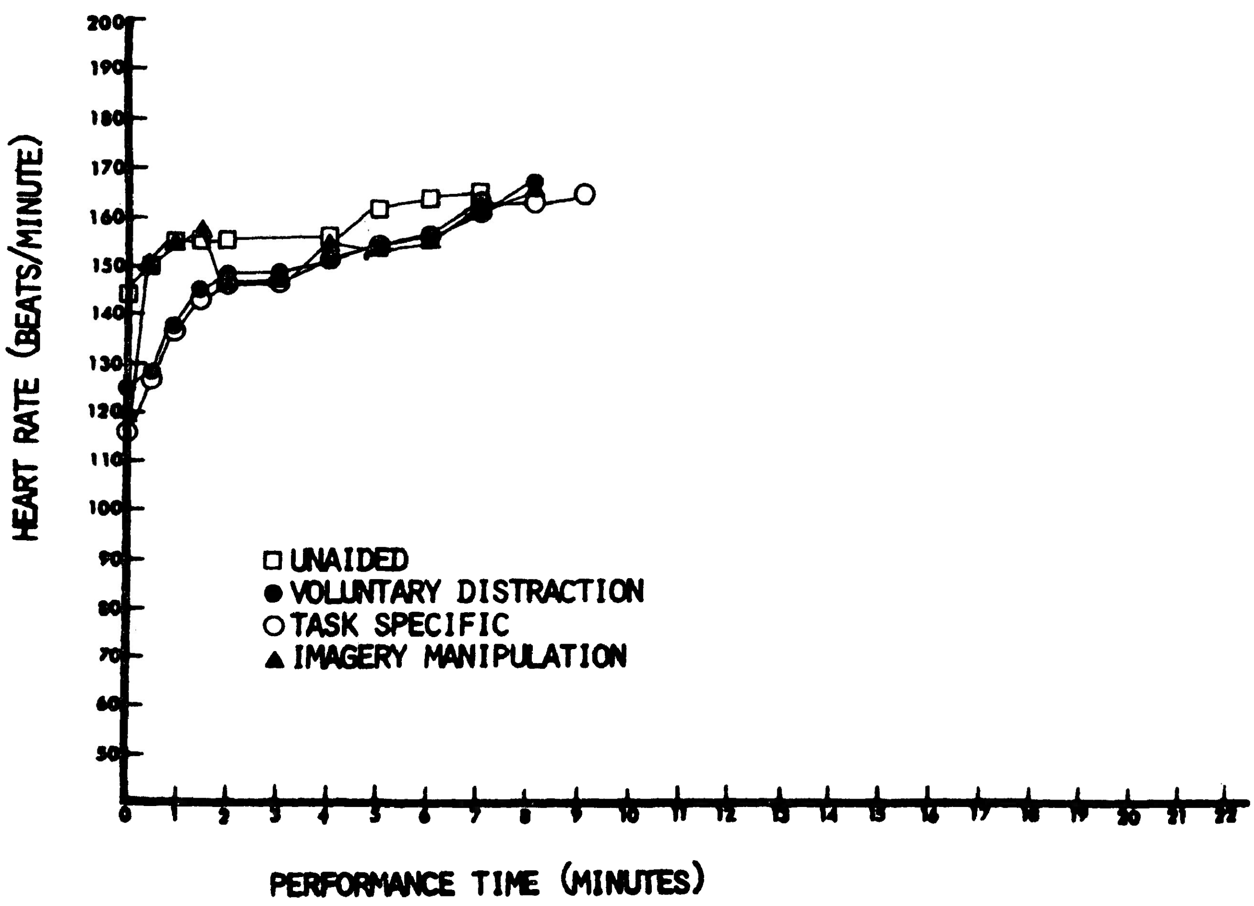
11
12
13
14
15
16
17
18
19
20
21
22
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION
PERFORMANCE TIME (MINUTES)

SUBJECT GK


200
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60
50
HEART RATE (BEATS/MINUTE)
□ UNAIDED
● VOLUNTARY DISTRACTION
○ TASK SPECIFIC
▲ IMAGERY MANIPULATION
0
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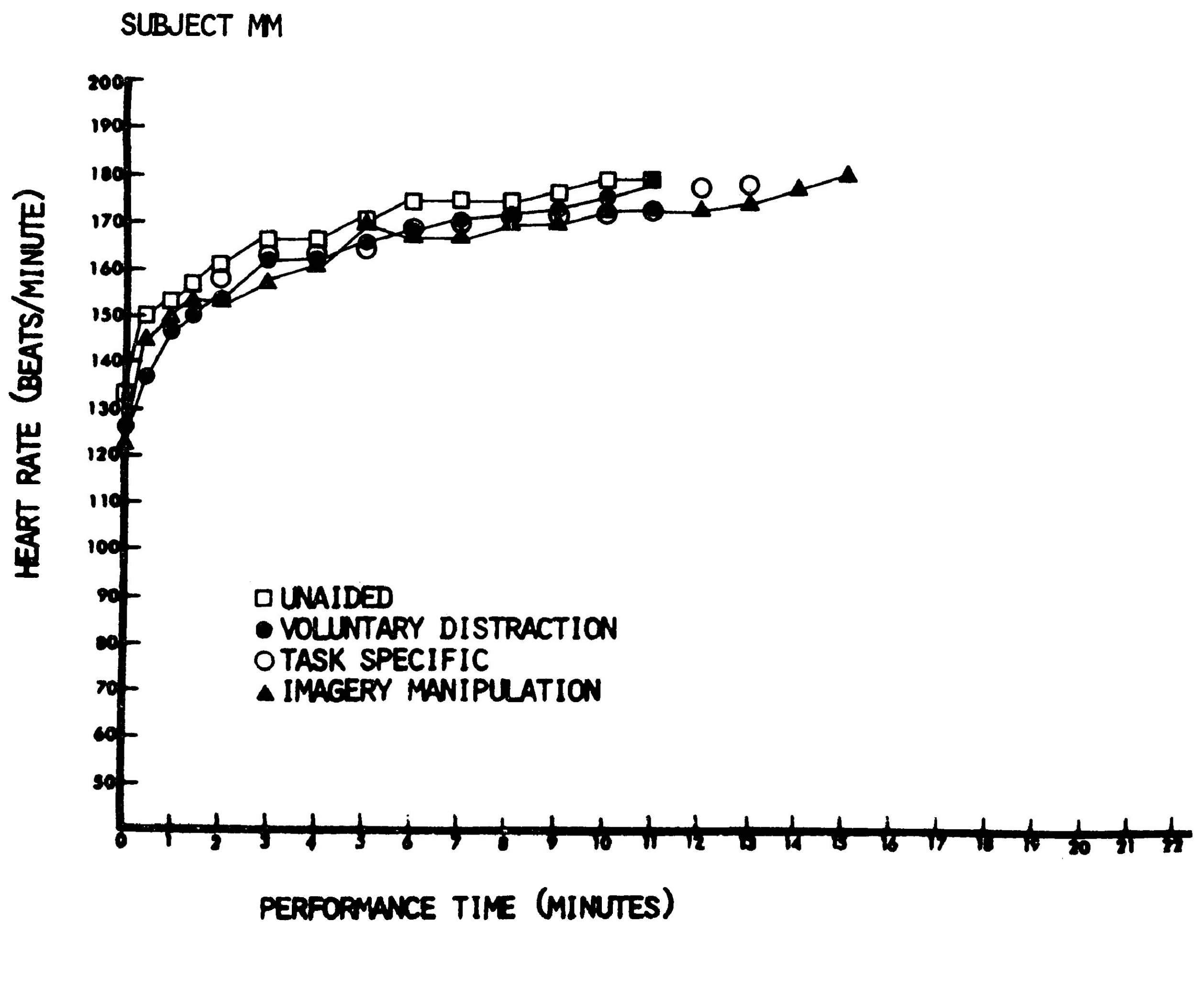
20
21
22
PERFORMANCE TIME (MINUTES)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HEART RATE (BEATS/MINUTE)
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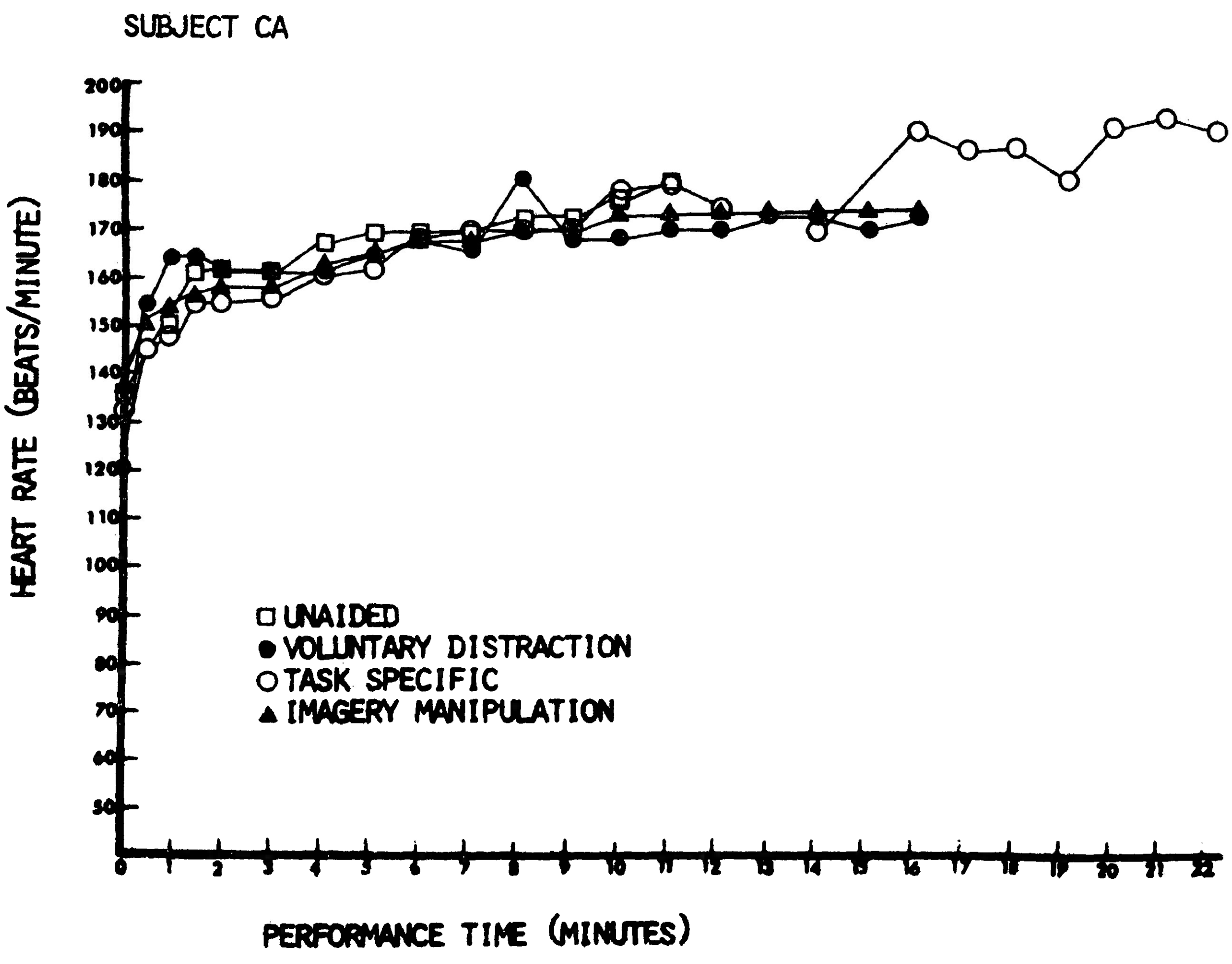
22
PERFORMANCE TIME (MINUTES)
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION


SUBJECT CA
HEART RATE (BEATS/MINUTE)
200
190
180
170
160
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60
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□ UNAIDED
● VOLUNTARY DISTRACTION
○ TASK SPECIFIC
▲ IMAGERY MANIPULATION
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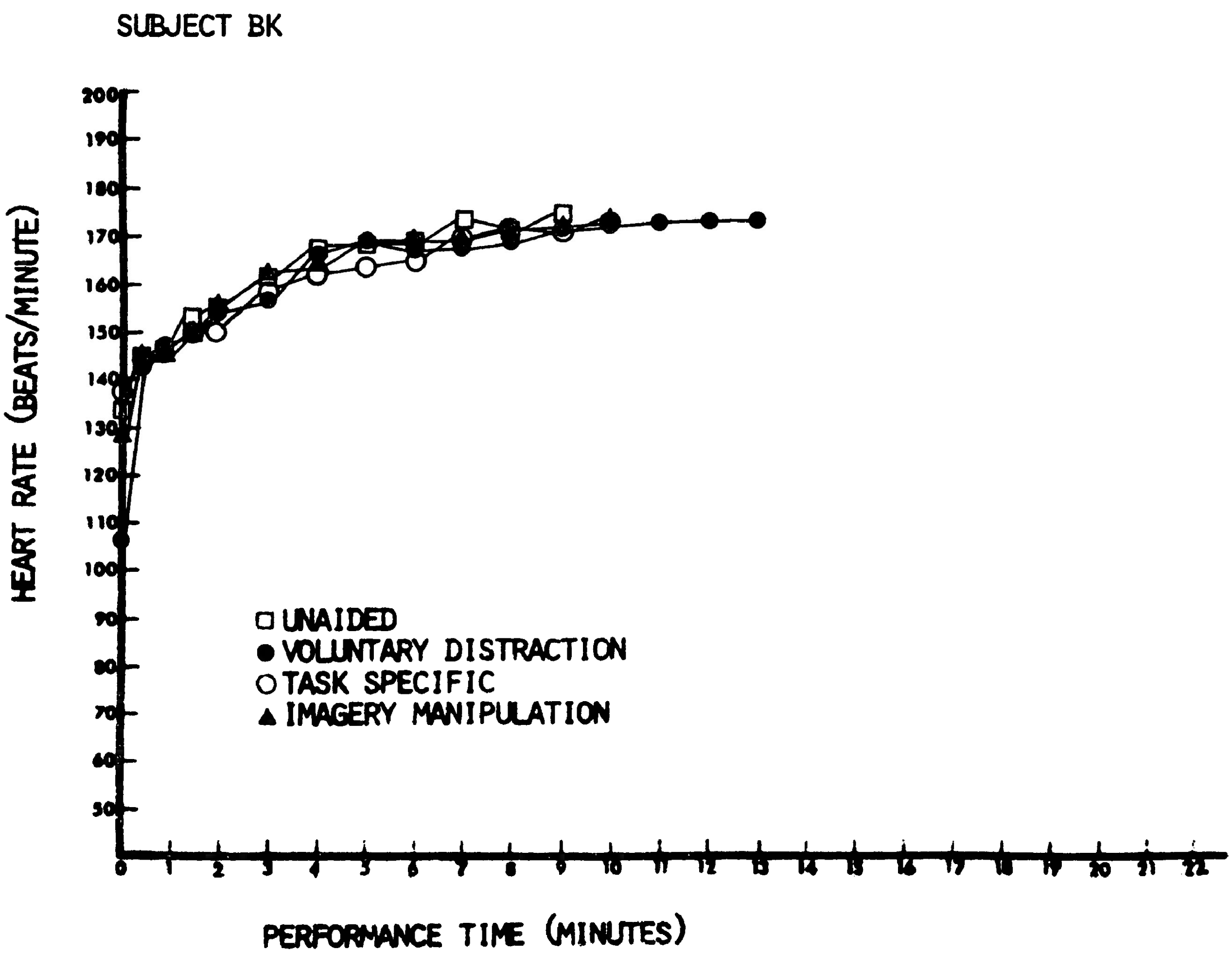
21
22
PERFORMANCE TIME (MINUTES)



SUBJECT BK
HEART RATE (BEATS/MINUTE)
200
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180
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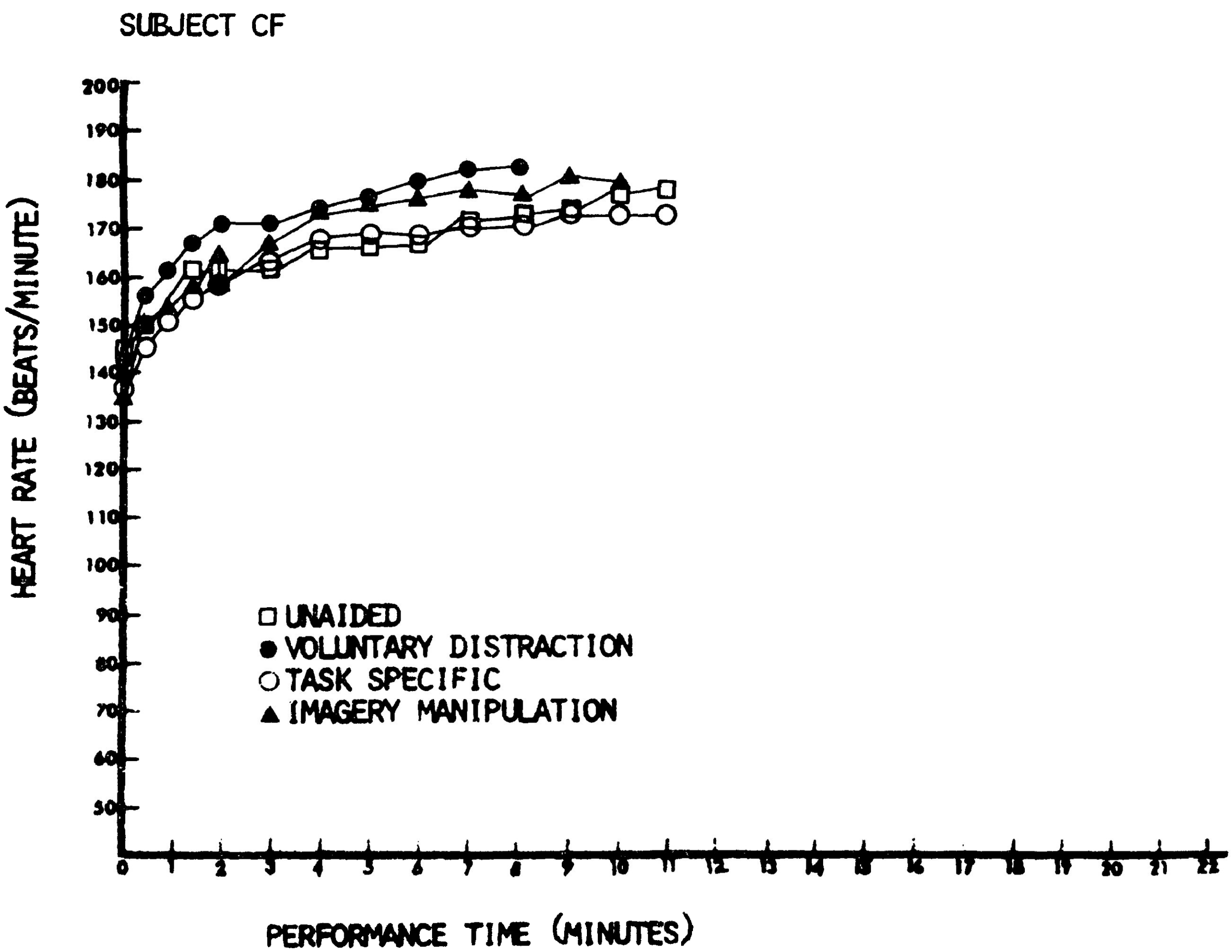
16
17
18
19
20
21
22
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION
PERFORMANCE TIME (MINUTES)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HEART RATE (BEATS/MINUTE)
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190
180
170
160
150
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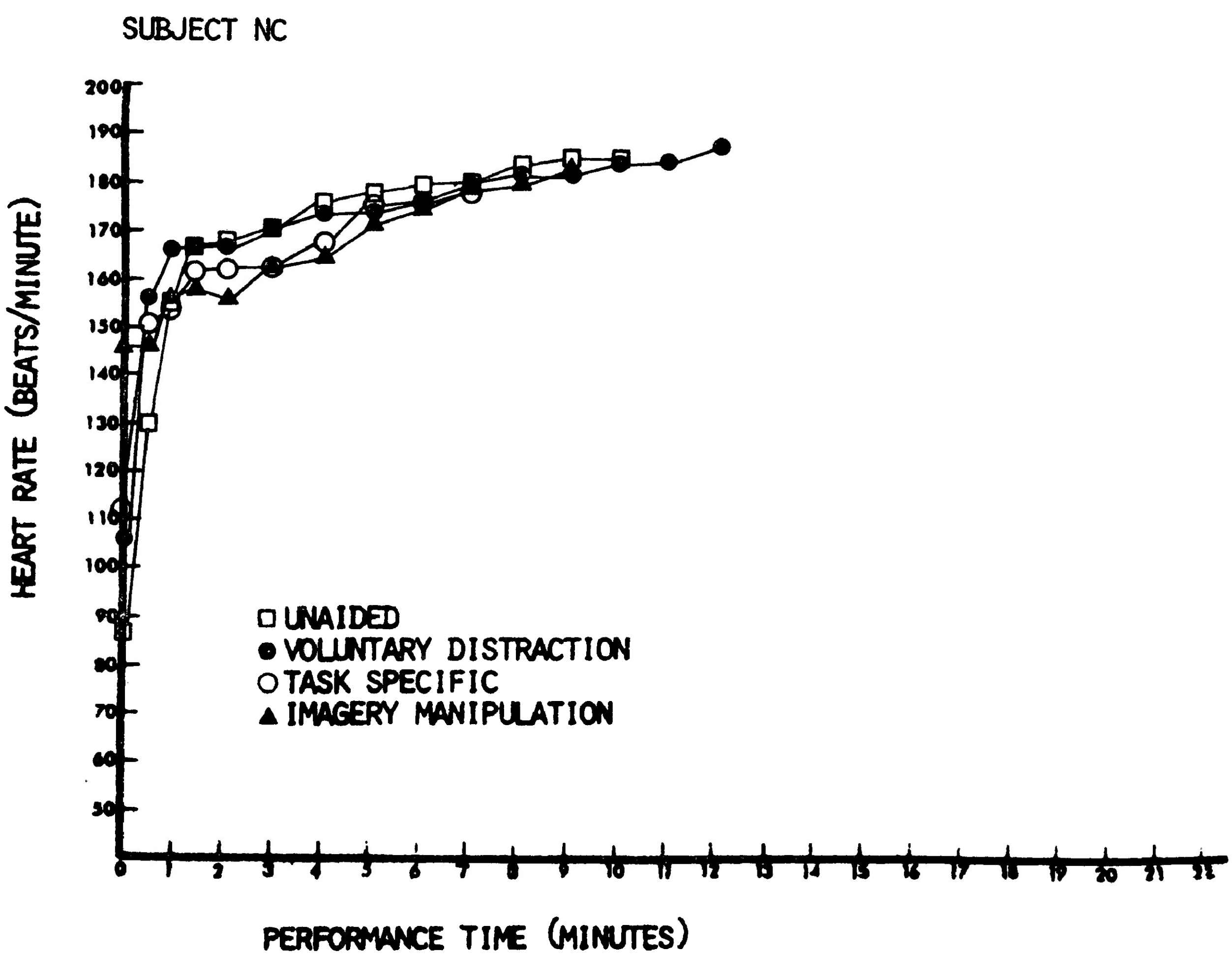
60
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
PERFORMANCE TIME (MINUTES)
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION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HEART RATE (BEATS/MINUTE)
200
190
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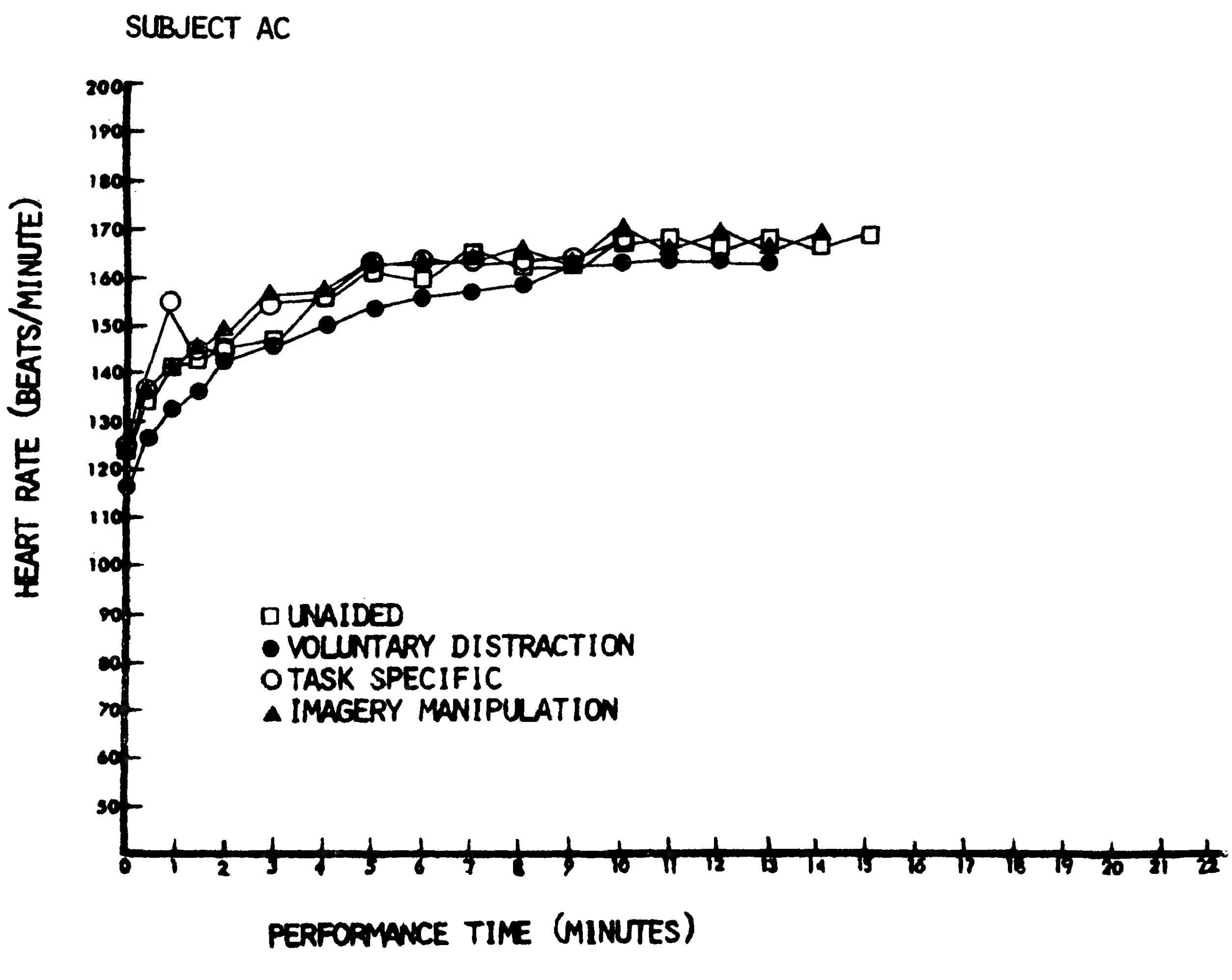
□ UNAIDED
● VOLUNTARY DISTRACTION
○ TASK SPECIFIC
▲ IMAGERY MANIPULATION
PERFORMANCE TIME (MINUTES)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HEART RATE (BEATS/MINUTE)
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190
180
170
160
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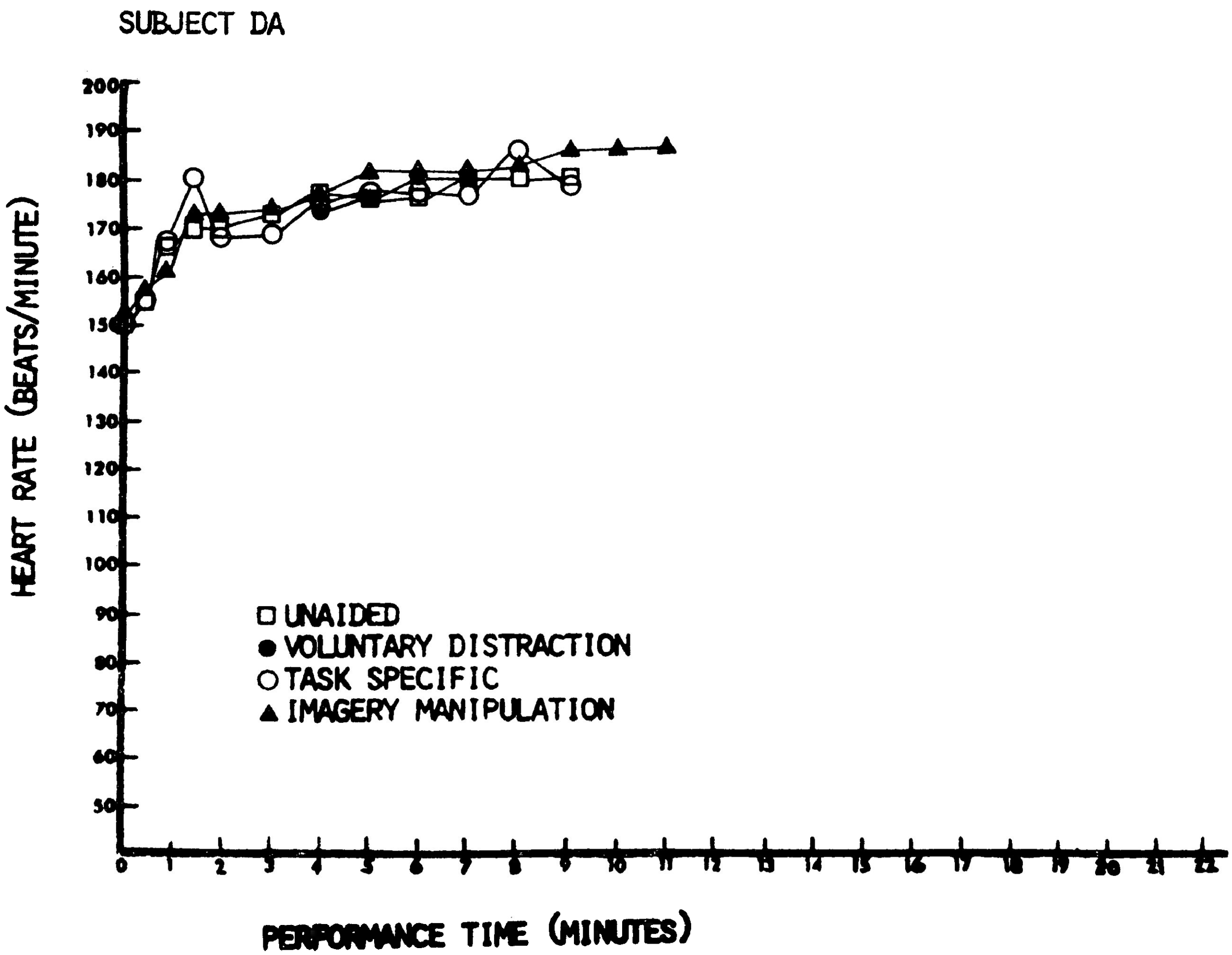
110
100
90
80
70
60
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
PERFORMANCE TIME (MINUTES)
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION


SUBJECT DA
HEART RATE (BEATS/MINUTE)
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190
180
170
160
150
140
130
120
110
100
90
80
70
60
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UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION
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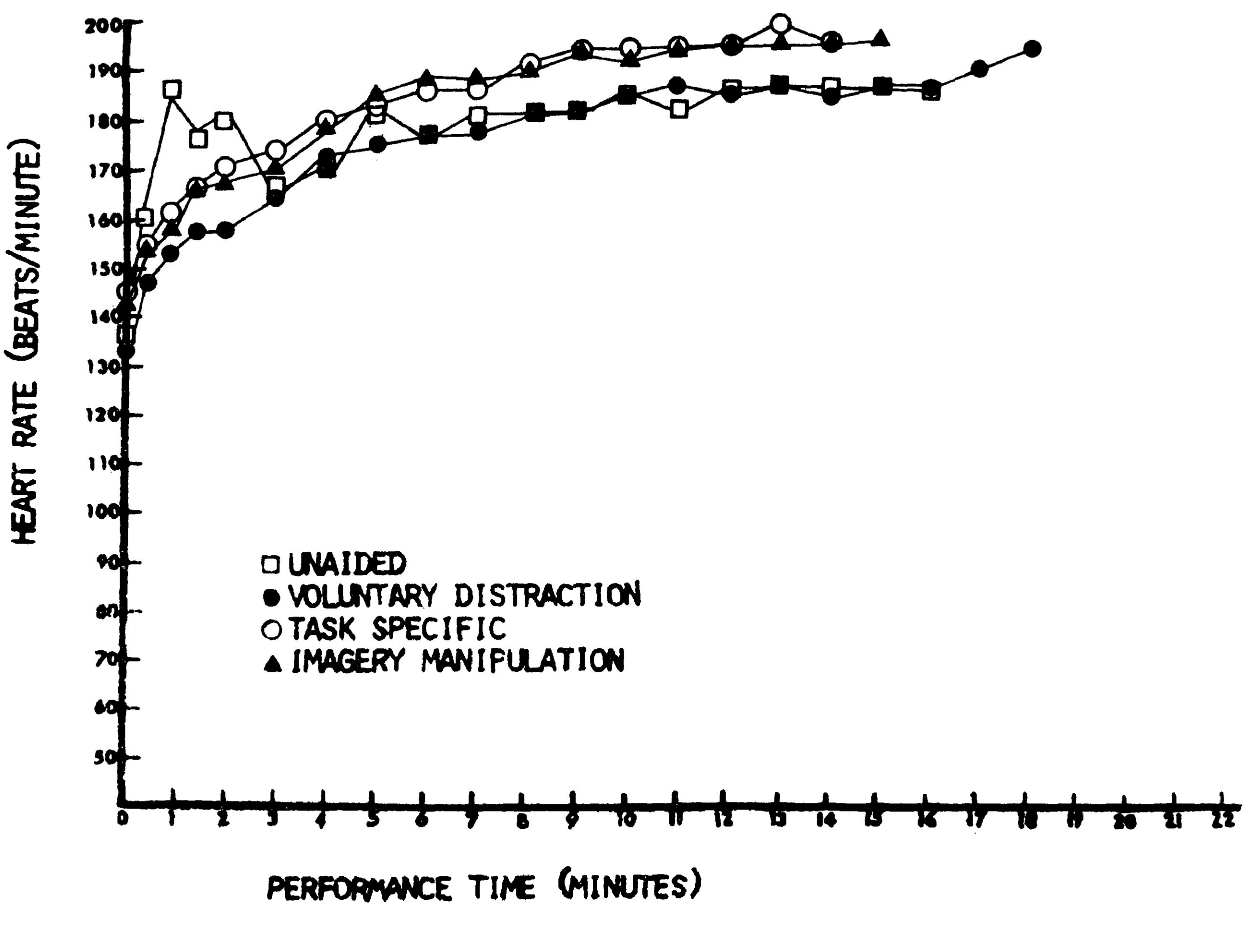
PERFORMANCE TIME (MINUTES)

SUBJECT KD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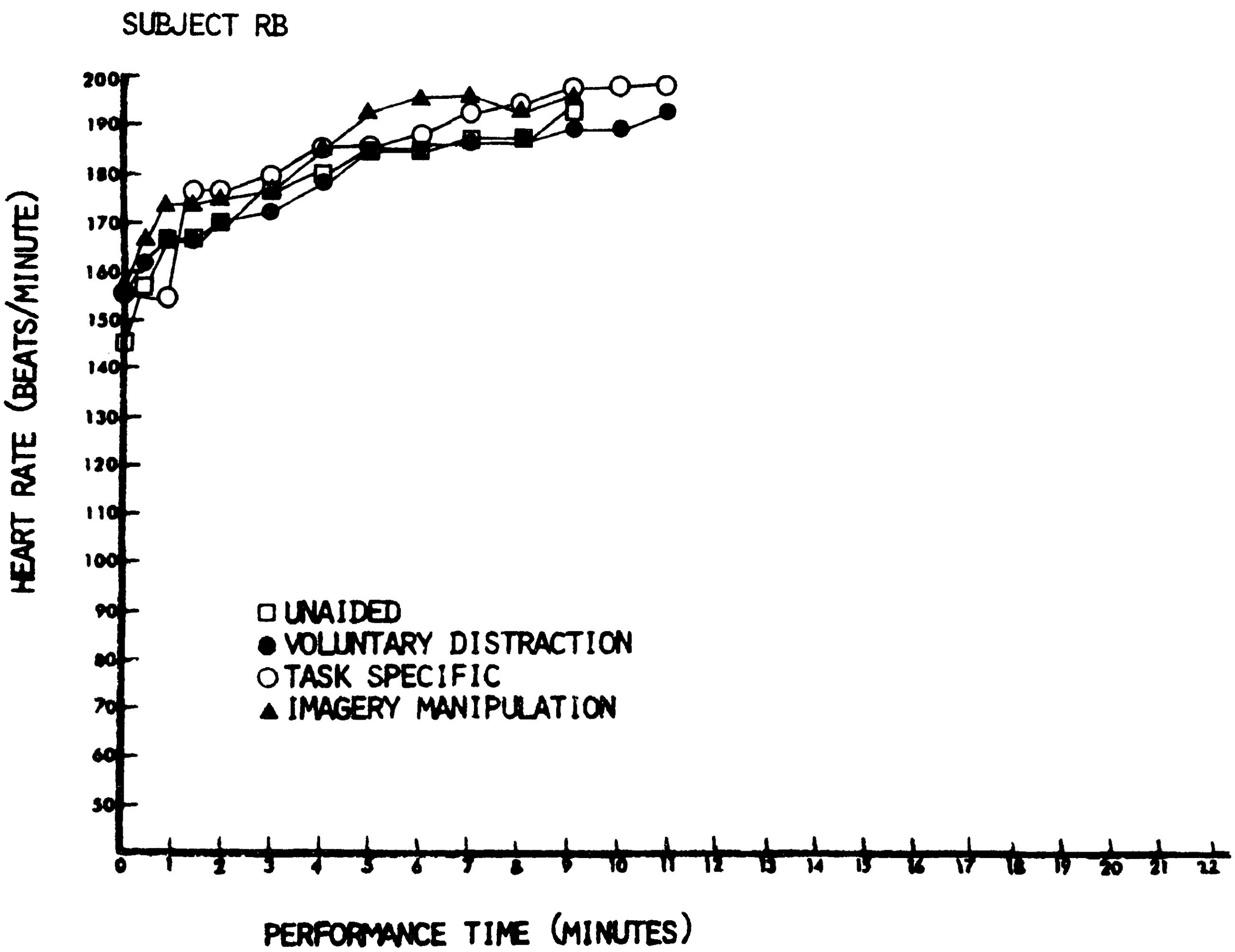
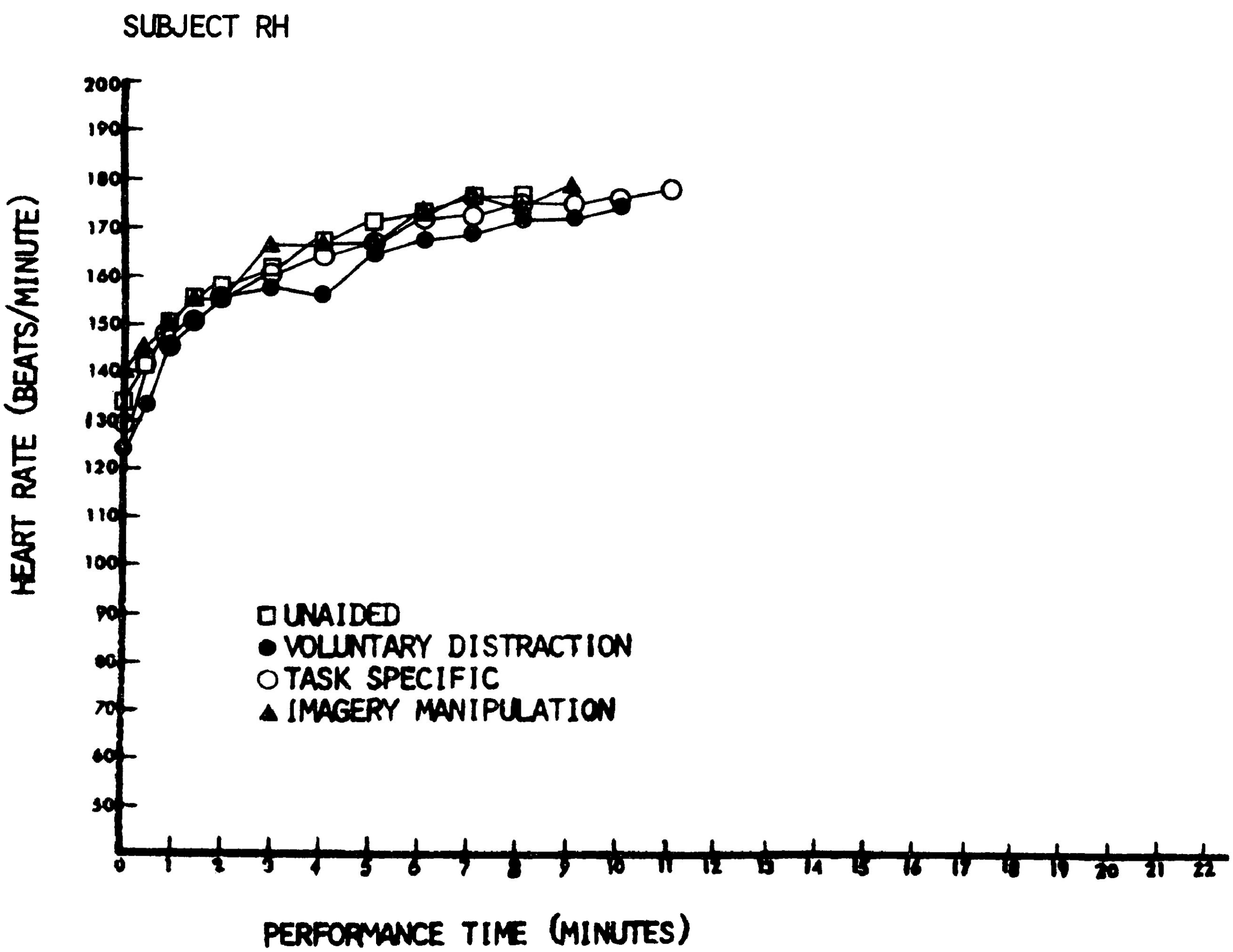
60
50
HEART RATE (BEATS/MINUTE)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
PERFORMANCE TIME (MINUTES)
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION



SUBJECT RB
HEART RATE (BEATS/MINUTE)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
PERFORMANCE TIME (MINUTES)
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION


SUBJECT RH
HEART RATE (BEATS/MINUTE)
200
190
180
170
160
150
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130
120
110
100
90
80
70
60
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
UNAIDED
VOLUNTARY DISTRACTION
TASK SPECIFIC
IMAGERY MANIPULATION
PERFORMANCE TIME (MINUTES)

APPENDIX B

Name: ____________________________

POSTTEST QUESTIONNAIRE

1. Were you able to think or do only what was asked of you all the way through the trial? If no please explain.

    YES NO

2. Did you: (circle the correct response)

    a) get enough sleep last night?

    YES NO

    b) consume alcohol last night?

    YES NO

    c) eat too much or too little food before the trial?

    YES NO

3. Was there any factor(s) hindering you from performing your best today? If so please explain.

4. What were your impressions of today's trial? Please explain including such things as your opinion of your performance, the trial, and what was asked of you etc.

APPENDIX C

POSTEXPERIMENT QUESTIONNAIRE

Name: ____________________

Date: ____________________

Please take time answering the following questions. Think over your responses before handing in this questionnaire.

During your last four runs on the treadmill a cassette recorder has asked you to do or 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. Think about anything you wish during the run and run until it was impossible to continue.
C. Imagine a scenic run through the countryside during the run and run until it was impossible to continue.
D. Concentrate only on your technique during the run and run until it was impossible to continue.

1. Which of the four conditions did you prefer and why?
2. Which of the four conditions did you feel was most effective in prolonging your run?
3. List in order from most effective to least effective, your overall assessment of the effectiveness of each condition in improving your performance.
4 Write down anything you think would be of value for me to know concerning your participation in this experiment.

APPENDIX D

Sample Sheet for Recording Performance Information

Name: ____________________

Date: ____________________

Condition: ________________

Performance Time: _________

Particulars:

Treadmill:
Speed ______
Grade ______
Blood Pressure: ______

Date: ____________________

Condition: ________________

Performance Time: _________

Particulars:

Treadmill:
Speed ______
Grade ______
Blood Pressure: ______

Date: ____________________

Condition: ________________

Performance Time: _________

Particulars:

Treadmill:
Speed ______
Grade ______
Blood Pressure: ______

Date: ____________________

Condition: ________________

Performance Time: _________

Particulars:

Treadmill:
Speed ______
Grade ______
Blood Pressure: ______

APPENDIX E

Example Statements and Words for Imagery Manipulation

Exhilarating

Lovely Autumn Leaves

Enjoyment

Fresh Air

Cool Gentle Breeze

Invigorating

Example Statements and Words for Task Specific

Rhythm

Head Still

Keep Moving

Relax Hands

APPENDIX F

Latin Square 1

Subject 1	A	C	D	B
2	B	D	A	C
3	D	B	C	A
4	C	A	B	D

Latin Square 2

5	D	A	B	C
6	A	D	C	B
7	B	C	A	D
8	C	B	D	A

Voluntary Distraction = A
Task Specific = B
Imagery Manipulation = C
Unaided = D

Latin Square 3

9	C	B	A	D
10	B	C	D	A
11	A	D	C	B
12	D	A	B	C

APPENDIX G

Latin Square 1

Subject	UA	VD	TS	IM
1	716 [3*] *173*	868 [1] *178*	792 [4] *173*	997 [2] *174*
2	453 [2] *162*	520 [3] *160*	554 [1] *162*	526 [4] *161*
3	715 [1] *178*	719 [4] *176*	782 [2] *175*	956 [3] *177*
4	659 [4] *176*	996 [2] *172*	1382 [3] *188*	999 [1] *173*

Latin Square 2

Subject	UA	VD	TS	IM
5	559 [4] *171*	824 [2] *170*	651 [3] *169*	625 [4] *171*
6	606 [2] *174*	520 [1] *179*	737 [4] *174*	653 [3] *176*
7	610 [4] *185*	776 [3] *185*	457 [2] *174*	556 [1] *177*
8	923 [3] *166*	812 [4] *163*	660 [2] *165*	852 [1] *169*

Latin Square 3

Subject	UA	VD	TS	IM
9	565 [4] *180*	461 [3] *179*	541 [2] *178*	664 [1] *187*
10	972 [3] *186*	1140 [4] *191*	896 [1] *196*	860 [2] *195*
11	622 [2] *188*	708 [1] *192*	661 [4] *195*	707 [3] *193*
12	523 [1] *175*	635 [2] *171*	698 [3] *174*	584 [4] *176*

Performance time in seconds

Heart Rate

UA = UNAIDED
VD = VOLUNTARY DISTRACTION
TS = TASK SPECIFIC
IM = IMAGERY MANIPULATION

* Numbers denote the order of presentation of conditions

APPENDIX H

Table of Performance Times in Seconds for Baseline Trials with Appropriate Treadmill Speed and Grade Denoted

Subject	Baseline Trial	Time	Speed	Grade
RL	1	1011	9	2
RL	2	258	10	2
RL	3	575	9.5*	2*
GK	1	231	9	2
GK	2	654	8	2
GK	3	479	8*	2*
MM	1	778	9	2
MM	2	1076	9	2
MM	3	791	9.5*	2*
CA	1	687	9	2
CA	2	1090	9	2
CA	3	448	10	2
CA	4	723	9.5*	2*
BK	1	415	9	2
BK	2	835	9	2
BK	3	554	9	3
BK	4	513	9.5*	2*
CF	1	597	9	2
CF	2	738	9	2
CF	3	558	9.5*	2*
NC	1	492	9	2
NC	2	750	9	2
NC	3	921	9	2
NC	4	490	9.5*	2*

* Experimental task speed and grade

APPENDIX H (continued)

Subject	Baseline Trial	Time	Speed	Grade
AC	1	548	9.	2
AC	2	885	9	2
AC	3	405	9.5*	2*
DA	1	995	9	2
DA	2	437	10	2
DA	3	536	9	3
DA	4	511	9.5*	2*
KD	1	706	9	2
KD	2	664	9	2
KD	3	732	9*	2*
RB	1	846	9	2
RB	2	943	9	2
RB	3	631	9.5*	2*
RH	1	176	8	2
RH	2	915	7	2
RH	3	499	7.5*	2*
RH	4	515	7.75	2

* Experimental task speed and grade