THE UNIVERSITY OF ALBERTA

THE PERFORMANCE AND HEART RATE RESPONSE OF TRAINABLE MENTALLY HANDICAPPED CHILDREN ON THE CANADA FITNESS AWARD-ADAPTED ENDURANCE RUN

by

SOCK MIANG KOH

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

PHYSICAL EDUCATION AND SPORT STUDIES

EDMONTON, ALBERTA

SPRING, 1986

ISBN 0-315-30283-6

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR : SOCK MIANG KOH

TITLE OF THESIS : THE PERFORMANCE AND HEART RATE RESPONSE OF TRAINABLE MENTALLY HANDICAPPED CHILDREN ON THE CANADA FITNESS AWARD-ADAPTED ENDURANCE RUN

DEGREE FOR WHICH THESIS WAS PRESENTED : MASTER OF SCIENCE

YEAR THIS DEGREE GRANTED : SPRING, 1986

(SIGNED) ....

PERMANENT ADDRESS:

#13-1081, APT. BLOCK 202

TOA PAYOH NORTH

SINGAPORE 1231

REPUBLIC OF SINGAPORE

DATED APRIL 22 1986

If any one lack wisdom, let him ask of God....

James I:5

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE PERFORMANCE AND HEART RATE RESPONSE OF TRAINABLE MENTALLY HANDICAPPED CHILDREN ON THE CANADA FITNESS AWARD-ADAPTED ENDURANCE RUN submitted by SOCK MIANG KOH in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE.

Jane Watkinson
....
Supervisor

....

....

Date APRIL 22, 1986

Abstract

The Canada Fitness Award (CFA) was adapted in 1983 as a means of testing the physical fitness of the trainable mentally handicapped (TMH). Since its introduction, nation wide data has indicated that approximately 80% of those who have participated in the CFA-Adapted program were unable to complete the endurance run.

This study stemmed from an increasing awareness that the CFA-Adapted endurance run may be testing for factors other than cardiovascular efficiency. The study was therefore designed with two main objectives. One of these objectives was to determine the effectiveness of a proposed pacing protocol in improving TMH children and youth's performance on the CFA-Adapted run. The other major objective was to determine the physiological response of such participants to the run by collecting heart-rate responses during the run.

Two different age groups, 10-12 year old and 13-and-older, were tested. A total of 23 TMH subjects, aged 10 to 17 years, were tested once every week for five consecutive weeks. To determine whether the proposed pacing protocol would improve running performance, experimental subjects were paced by pacer-prompters during the second, third and fourth testing sessions. All paces were individually determined for each subject based on pretest performance and on subsequent performances. Control subjects ran independently according to the current protocol for all testing sessions. To determine the physiological responses of TMH subjects to the run, microcomputer Sport-testers were utilized to collect heart-rate responses of subjects over every 30-second interval during the run.

Results from this study showed that for both age groups tested, the proposed pacing protocol was able to increase the rate of completion of TMH

subjects on the CFA-Adapted endurance run. However, when the times taken to complete the run were analyzed, the effectiveness of the proposed pacing protocol in improving performance differs for both age groups tested. Results of the 10-12 year old group showed that the proposed pacing protocol was effective in improving the time taken by subjects to complete the run. On the other hand, results of the 13-and-older group did not provide any substantial support to suggest that the time taken to complete the run can be effectively improved by the proposed protocol. Despite this lack of inter-group trend, it was noted that there was a general trend of better performance by lower ranked subjects in both age groups. Tremendous interindividual differences in performance were also observed.

Heart rate data did not support the assumption that TMH subjects perform at a low to mild intensity level during the run due to motivational and cognition problems. Contrary to such an assumption, heart rate data points showed that the subjects, especially those who were younger, were performing at extremely vigorous to severe intensity levels. Heart rate data also indicated that TMH subjects were performing near maximum cardiovascular capacities. Group and individual heart rate data also indicated less variability in heart rate response patterns when the proposed pacing protocol was used. The CFA-Adapted endurance run is therefore a demanding cardiovascular endurance test for the TMH subjects tested, particularly when subjects are paced and prompted throughout the run.

ACKNOWLEDGEMENTS

I am indebted to many individuals who helped in many ways toward the completion of this thesis and my graduate program. Sincere thanks and appreciation are extended to..

... Drs. G. Kysela and R. Macnab, my committee members, for their thoughtful questions and comments. Special thanks must be given to Dr. Macnab for his great sense of humor.

... the children and teachers who participated in this study. This study would not have been possible without their full co-operation and enthusiasm.

... the many instructors, pacer-prompters, pace-keepers and time-keepers who helped throughout the five testing sessions. I want to especially thank Carol Chung, a dear friend, for her assistance and companionship throughout the study. Special appreciation is also extended to Victor Lew for his help in 'pulling curtains' and pacing the subjects.

... my family, especially my grandmothers and Uncle Choon Hui, for believing in me and inspiring me to strive for excellence.

... members of my church family at Westwood Baptist Church. Special thanks must be extended to Pastor & Mrs. Bye, Ismael & Gwen Ausmolo, and Linda Youell for the rich Canadian experiences that I have been introduced to during my stay in Edmonton.

... 'unique' members of my 'Happy Family" (Carol, Mui, Mei, Connie, Siew Ching, Yew Har, Moong & Boo) in Edmonton who helped to make student life more interesting and 'bearable'.

... Karen Lee, whose encouragement and thoughtful comments and questions challenged me to think 'creatively'.

... Hong for his support and encouragement.

Finally, I want to thank two very special individuals who have touched my life in a special way. I will always be thankful that I was given the privilege of knowing them and working with them. They are ..

... Marcel Bouffard, my instructor, counsellor, colleague, 'unofficial' research design and statistics advisor, and friend who challenged me to think critically, and to stick to the challenge during the times when I felt like 'giving up'. Words cannot express my appreciation to him for his faith in me; and for reminding me that the perfect research design has yet to be discovered, and hence ease my apprehensions about going ahead with this study.

... Dr. Jane Watkinson, my advisor and friend who patiently nurtured and guided me through the course of my graduate program and this study. Without Jane, I would never have started the graduate program nor learned the joys of working with children with mental retardation. I pray that my future endeavours will merit her faith and confidence in me.

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

The Canada Fitness Award (CFA)-Adapted program was designed to assess the physical fitness of children and youth with moderate mental retardation in a manner similar to the regular CFA program used with the non-handicapped population. The Adapted format arises out of concerns expressed during the major revision of the regular CFA (1978-1979) that certain adaptations were needed to make the CFA valid and available to special populations (Findlay, 1981). A task force, appointed by the CAHPER Adapted Committee to look into this matter, selected the trainable mentally handicapped (TMH - refer to Definition of terms, pg. 15) as the target population to determine if such an action was feasible. The TMH population was selected because:

> ...it provides a very accessible group to which an Adapted fitness test could prove to be beneficial. (Findlay, 1981, p.5)

In 1983 the CFA-Adapted for TMH was finally completed and introduced.

The collection of normative data from 3,172 TMH children on the six test items of the CFA revealed that a large percentage of the target group was unable to complete the endurance run, a test item that was used to evaluate cardiovascular endurance (Findlay, 1983). The completion of the endurance run is required for receipt of a CFA award. The percentage of incompletion ranged from 74% to 94% for girls (8 to 13 year olds and above), and 76% to 88% for boys (8 to 13 years and above) (See Appendix A). Futhermore, those who were able to complete the run did so with scores that were significantly below those expected of individuals with minimal level of fitness.

Speakman (1977a; 1977b) suggests that there are three major concerns about the test items used to assess physical fitness of the mentally handicapped (MH):

1) The test item may be physically too difficult for MH children to perform,
2) The test item may be motivationally too demanding, and
3) The test item may be too complicated for the MH to produce maximal performance/effort.'

An additional concern about test items used with the MH is that some items require strategy planning and cognitive appreciation of what the items demand (Peries, 1976). A number of studies have demonstrated that it is not only low physical fitness levels, but also the lack of motivation, task complexity and/or lack of understanding of the task that can indeed prevent the MHs from performing their best (Fait & Kupferer, 1956; Speakman, 1977a; Wagner, 1967).

Katch, Pechar, McArdle & Weltman (1973) have suggested that endurance runs are 'uncontrolled' exercise tests where pacing errors may cause subjects to perform in a manner inconsistent with their true cardiovascular capacity. Other investigators have cautioned that several other potential factors could profoundly influence running performance. Some of these factors include running efficiency (Nagle, Robinhold, Howley, Daniels, Baptista & Stoedefalke, 1970), anaerobic involvement (Nagle et al., 1970), motivation and willingness to accept and endure the discomfort and pain of strenous effort (Morehouse & Miller, 1976). Sonstroem (1974) and Dishman (1978) have presented research findings to suggest that motivation may account for as much as 18% of performance variance in the 12-minute endurance run. The validity of any running test as a measure of cardiovascular fitness for children was also questioned by

Corbin (1973), who was of the opinion that many confounding problems could arise from an inadequately developed concept of pacing, or from a child's short attention span for monotonous tasks such as running laps. Considering the appropriate pacing and motivational demands of the endurance run, it is possible that the validity of the CFA-Adapted endurance run is therefore confounded by variables other than cardiovascular endurance, the fitness component which the run purports to measure. For example, utilizing the Hayden Fitness Test with a subjective evaluation criterion, Speakman (1977a) found that of the eight test items (flexed arm hang, medicine ball throw, back extension flexibility, speed back lifts, speed sit ups, vertical jump, floor touch flexibility and 300 yard run), the 300 yard endurance run was the most motivationally demanding test item. Objective means of determining the degree of physiological difficulty and level of exercise intensity that non-MH and MH subjects work at, during the endurance run, have yet to be reported. It is thus very difficult to determine objectively and accurately whether the subpar performance of the TMH on the CFA-Adapted endurance run is due to low cardiovascular fitness or motivational and/or physiological parameters. It is acknowledged that the endurance run does provide a fairly good indication of cardiovascular endurance in the non-handicapped population (Cooper, 1968b). However, when used with the MH, the standard testing protocol of the run often renders it invalid because such protocols often ignore the particular psychological and behavioural characteristics that often accompany mental retardation. Also, to continue using the CFA-Adpated endurance run as it currently stands, testers/teachers may run the risk of promoting negative feedback to TMH participants. Since only about 20% of TMH children were able to complete the run, about 80% of those who have taken the CFA-Adapted program may be negatively reinforced by their failure to complete the run. Studies have cautioned that continual failure can have detrimental effects upon the MH.

A possible reason for the TMH's inability to complete the endurance run could be the lack of cognitive appreciation for the demands of an endurance run. Such a possibility indicates the need for some form of pacing system when testing this group. It is noteworthy to mention that McArdle, Katch and Katch (1981) have cautioned that there is also a crucial need to establish effective pacing for normal, inexperienced subjects during an endurance run test. Sherrill (1981) also alluded to the need for pacers, and/or pacing strategies for the MH in order to elicit maximal performance. However, a systematic pacing system that can be used with the MH has yet to be developed or reported. Established test batteries have generally recommended that when the TMH are tested, a pacer be used "whenever possible". For example, the CFA-Adapted test manual suggests that testers encourage an 'even pace' or that volunteers be used to help pace participants. Recommending that testers/teachers use a pacer, without providing them any systematic pacing system or guidelines, does not provide any helpful or significant direction as to how pacers and/or pacing strategies should and can be utilized. There is therefore a need for a simple, well tested systematic pacing system to be made available to testers or teachers testing the TMH, so that better performance on the endurance run can be elicited. The testing experience may also be a more positive experience for the TMH if success is made more attainable by an effective pacing system.

THE CANADA FITNESS AWARD PROGRAM

The CAPHER Fitness Performance Test was developed in 1963 by the Research Committee of CAPHER to:

1) evaluate the fitness of Canadian children and youth from ages 6 to 17, and
2) motivate Canadian children and youth toward a higher level of fitness by providing awards as incentives (Dahlgren, 1982).

The six test items that made up the initial CAPHER Fitness test were:

1) speed sit ups
2) standing broad jump
3) flexed arm hang
4) agility/shuttle run
5) 50 yard dash
6) 300 yard run.

Norms for the test were derived from normative data collected on approximately 11,000 school children and youth and published in 1967 (Dahlgren, 1982). In 1970 the Fitness and Amateur Sport Branch officially launched the Fitness test as the Canada Fitness Award (CFA) to encourage more wide spread usage of the test.

Concerns regarding the CFA raised by CAPHER professionals led to a major revision of the CFA in 1979 (Dahlgren, 1982). The major changes made to the CFA were:

1) changing the measurement standards from imperial to metric units,
2) replacing the 300 yard run with longer distances that would provide better indicators of aerobic capacity, and
3) updating the norms.

Major revisions to the CFA program were once again made in 1984. This was by far the most significant revision that the CFA has undergone - the flexed arm hang test was replaced by a push up test while the speed sit up test was modified into partial curl ups. The six test items that presently constitute the CFA program are:

1) push ups
2) partial curl ups
3) standing long jump
4) shuttle run
5) 50m dash
6) endurance run (800m, 1,600m & 2,400m)

THE CANADA FITNESS AWARD - ADAPTED FOR THE TMH

During the major revision of the CFA program in 1979, considerable interest was expressed by CAPHER professionals and others with regards to the feasibility of using the CFA with special populations such as the mentally handicapped, the blind, the deaf and the physically handicapped (Findlay, 1981). The responsibility of determining the feasibility of developing adaptations to the CFA program for special populations was undertaken by a 6-person task force appointed by the Adapted Committee of CAPHER.

> It was the consensus of the task force that a limited scope had to be used in order to develop a usable test resource. By trying to encapsulate all special population constituents, the task force would be extending itself beyond practical limits. Thus, the mentally handicapped was selected as a target group as it provides a large homogenous group... (Findlay, 1981)

The trainable mentally handicapped (TMH) population was finally selected as the target population to which CFA adaptations would be made. The project went through three major phases, where CFA test items were tested on the TMH, and all necessary modifications made and retested. Collection of normative data from 3,172 TMH participants during the third phase of the project enabled norms to be established and in 1983, the CFA-Adapted for the TMH was formally introduced.

The CFA-Adapted, in keeping with the CFA program, was initially made up of the following six test items:

1) sit ups (level 1 to 3)
2) standing broad jump
3) flexed arm hang (level 1 to 3)
4) shuttle run
5) 50m dash
6) endurance run (600m for 7-9 year old, 1,200m for 10-12 year olds & 2,000m for those 13-and-older).

Following the major revisions made to the regular CFA in 1984, the CFA-Adapted was also revised. The sit-ups test is now replaced by the curl up test while the flexed arm hang is replaced by a push up test.

The major adaptations made to the regular CFA program were the scoring and testing procedures, the number of trials permitted, and most important of all, the breaking down of two test items, the curl up and the push up, into more manageable sub-tasks through task analysis of the test items. Hence a sequence of sub-tasks was introduced to make for easier acquisition of the skill required to perform the CFA test items by TMH children and youth where this was warranted. It was hoped that such adaptations would eliminate the possibility that the TMH's performance on the CFA program was limited by learning variables (Findlay, Watkinson, Dahlgren, Evans, Lafreniere-Joannette & Bothwell-Meyers, 1984).

The major differences between the regular CFA and the Adapted format endurance run are:

1) the distance to be completed for the different age groups, for example :
   i) 6-8 year olds taking the regular CFA endurance run have to run 800m compared to 600m for 6-8 year old TMHs.
   ii) 10-12 year old normals run 1,600m while TMH counterparts run 1,200m.
2) the criterion times set for every 200m in the Adapted format. TMH runners have to come within or equal to the criterion times for every 200m to be allowed to continue the run. The run test is immediately discontinued when the criterion times are not met. No such criterion times are imposed in the regular CFA run.

PURPOSE OF THE STUDY

In order to qualify for an award in the CFA-Adapted program, TMH participants must be able to complete the endurance run within the criterion time set for each age and sex group (See Appendix B). Data obtained from nation-wide testings across Canada showed, however, that less than about 20-25% of 3172 tested participants were able to complete the run. Such below average performances have given many professionals in the field reasons to be concerned. Besides the acknowledged truth that the fitness level of the TMH is generally inferior, many other reasons have also been put forward to try and account for the reported results. Some of the reasons include the difficulty in motivating the TMH to run long distances; cognitively, the TMH may not be able to understand what it means to run 1200m or 2000m, and also lacks the strategy and pacing abilities to allow him/her to perform well on the run. Also, the endurance run may be physically too demanding for the TMH.

The present study stemmed from an increasing awareness that TMH participants may be tested for factors other than cardiovascular efficiency in the endurance run. In light of all these concerns and doubts concerning the appropriate continual use of the CFA-Adapted endurance run, coupled with the apparent lack of data and information on how TMH children and youth respond physiologically during the endurance run, the present study was designed with two basic objectives. Firstly, the study sought to describe the physiological response of TMH children and youth to the endurance run by collecting heart rate (HR) data over every 30 seconds during the run. Collection of heart rate measures during the run would provide a more objective determination and indication of the level of physical demands or exercise intensity that TMH subjects were working at. Availability of such data may therefore make it possible to tease out whether there are other variables (eg. motivation, cognitive appreciation of the task) operating during the run to influence the observed results. More accurate and valid inferences may thus be possible.

The second major purpose of this study was to investigate the feasibility of changing the current CFA-Adapted endurance run testing protocol to minimize the effects of two potentially confounding variables, namely, motivation and strategy planning (ie. pacing). More specifically, the study investigated whether the performance of TMH subjects on the endurance run could be improved by using a pacer-prompter to pace the subjects at appropriate pre-determined paces. A systematic pacing system was thus developed as part of this study to examine its effect on performance. To determine whether the current and proposed testing protocol would have any different effects on cardiovascular processes, comparison of heart rate response patterns to the two protocols therefore had to be made.

The study therefore attempted to answer the following questions :

1) When the proposed pacing protocol is used instead of the current protocol, will there be a difference in the proportion of TMH subjects who can complete the run?

2) Is there a difference in TMH children and youth's performance on the CFA-Adapted endurance run (ie. time taken to complete the run and/or award level achieved) when a pacer-prompter is used versus when a pacer-prompter is not used?

3) What is the exercise intensity level that TMH children and youth worked at during the CFA-Adapted endurance run? Specifically, what is the heart rate response pattern of the TMH subjects at every 30 second intervals of the run?

4) Is there a difference in the heart rate response patterns of the TMH subjects when:

   i) the current testing protocol is used?

   ii) the proposed pacing protocol is used?

5) Is there a difference in the heart rate response patterns of 10-12 year old TMHs when compared to 13 and older TMH subjects?

HYPOTHESES

To facilitate the direction of the study and have a better understanding of the results that would be obtained, the following hypotheses were made.

Hypothesis #1

The proposed systematic pacing protocol will increase the proportion of TMH children and youth who can complete the run.

Hypothesis #2

The performance of TMH children and youth on the CFA-

Adapted endurance run (ie. time taken to complete the run and/or award level achieved) can be improved by using a systematic pacing strategy where pacer-prompters are utilized to run with them.

Hypothesis #3

When pacer-prompters are removed from TMH subjects after three experimental pacing sessions, the performance of these subjects will fall off while control subjects' performance will remain fairly consistent across testing sessions.

Hypothesis #4

TMH children and youth generally work at a low to mild exercise intensity level (HR ranging from about 120 to 140 beats per min.) during the CFA-Adapted endurance run when the current test protocol is used.

Hypothesis #5

TMH subjects will work at a higher and more consistent exercise intensity level when the proposed pacing protocol is used.

LIMITATIONS OF THE STUDY

This study is limited to TMH children and youth who have no known cardiovascular diseases and who have received parental consent to participate in the endurance run. The sample selected may therefore not be representative of the target population if only "fitter" children and youth were given permission to participate. Parents and/or guardians of mentally handicapped children and youth are generally very protective of their children's welfare and are hence highly sensitive to any potential risks that are inherent in any physical activities. As such, parents of "less fit" children may tend to refuse permission for their children's participation in the study. Of the 26 subjects originally selected for this study, two 10-12 year old children were not given permission to participate. The generalizability of the results may therefore be limited.

Although it is acknowledged that a few practice trials are necessary to familiarize the TMH subjects with the run, and hence provide a better indication of their performance, only one pretest trial was conducted. The limitation of using only one pretest trial is acknowledged. Unfortunately, under the constraint of time, facility and equipment availability, the study had to be so designed. Ecologically this may be valid because TMH participants are seldom allowed more than one trial run in the actual school testing situation.

New and validated Sport-testers were used to measure the HR responses of the subjects during the run. The degree of accuracy of the physiological responses of subjects based on the HR data collected is, to a certain extent, limited by the accuracy and functioning of the Sport-testers. Although every attempt was made to prevent the subjects from manipulating the Sport-testers during the run, there were a few instances where data were lost because subjects either accidently or intentionally pressed the dials controlling the testers.

DELIMITATIONS

The CFA-Adapted format is designed to test TMH children and youth in three different age categories, 8-10 year olds, 10-12 year olds and 13 and older youth. In this study only the latter two age groups were used. The youngest age group was excluded from the study due to unavailability of subjects. The sample is therefore delimited to those TMH children and youth who are between 10 and 17 years of age and attending classes designated for TMH in the Edmonton Catholic School System.

The CFA-Adapted for the TMH has a total of six test items. In this study only the endurance run was tested. This study is therefore not an attempt to evaluate the entire CFA-Adapted program. Rather, it was designed to determine the physical demands of the endurance run and also the effect that a proposed pacing protocol may have upon the TMH's performance on the endurance run.

INDEPENDENT AND DEPENDENT VARIABLES

Independent Variables

The independent variables used in this study were:

1) Age

Two age groups were used in this study: 10-12 year olds and 13-and-older. Male and female subjects were included in the 10-12 year old group while only males were used in the 13-and-older group.

2) The protocols to be used for administering the CFA-Adapted endurance run:

<u>The Current CFA-Adapted protocol</u>

The current test protocol, as described in the CFA-Adapted for TMH manual (1985), recommends a maximum ratio of 3 participants per time-keeper per test trial. TMH participants must meet or better the criterion times set for every 200m for his/her age group to be allowed to continue the next 200m (See Appendix B). Verbal encouragements were provided to the subjects during the study.

<u>The Proposed Pacing protocol</u>

The proposed test protocol recommends the use of pacer-prompters and pace-keepers. Pacer-prompters ran and set a pre-determined pace based on the subject's performance time on the pretest (See Appendix D). Pacer-prompters ran ahead of subjects and provided verbal encouragements and instructions to subjects. Pacer-prompters were not allowed to provide any physical assistance to subjects, for example, pushing from behind or holding onto the subject's hand. The criterion times used in the current test protocol were not adhered to in the proposed protocol. Instead the criterion that was used for terminating the run was: if subject was 200m behind the pacer-prompter, the test was discontinued. To keep the pacer- prompters at the right pace, 2 pace-keepers were used. Since a 200m track was used to conduct the run, a pace-keeper was stationed at each 100m mark. Pace-keepers had the pre-determined pace times computed for each alternate 200m (See Appendix E for a sample pace card) and counted out loudly from 10 to 0 to indicate to the pacer-prompters that they should be passing the respective 100m when the count reached zero. A maximum of 3 subjects per pacer-prompter at any pre-determined pace was tested for any one trial.

Dependent Variables

The dependent variables used in the study were:

1) HR response in beats per minute averaged over every 30 second interval,
2) The time taken to complete the required distance,
3) The Best Treatment time (Best-T-time). This time refers to the fastest of the three times recorded during the treatment sessions,
4) The Mean Treatment time (Mean-T-time). This variable refers to the mean of the three treatment times,

5) The award level achieved,

6) The proportion of subjects who completed the required distance, and

7) The total distance completed.

DEFINITION OF TERMS USED

Pacer-prompters

Instructors who ran and set the pre-determined pace for experimental subjects during the three treatment sessions.

Pace-keepers

Time keepers stationed at each 100m mark of the 200m running track. They were responsible for keeping the pacer-prompters at the correct pace.

A Sport-tester

An instrument, consisting of a pulse transmitter attached onto an electrode belt, and a receiver microcomputer. The Sport-tester can monitor and store heart rate responses for every 30 second interval in its memory function for up to 64 minutes. The pulse transmitter connected to the electrodes is in wireless contact with its watch-like receiver microcomputer. The electrode belt is worn around the chest at about the 5th intercoastal level while the watch-like receiver is worn on the wrist.

Trainable Mentally Handicapped (TMH)

'Trainable mentally handicapped' is a general educational classification often used for individuals with moderate mental retardation, and is "intended to be descriptive of the educational needs of the retarded individual" (Seaman & Depauw, 1980). The American Association on Mental Deficiency generally classify children whose IQ scores fall between 36 to 51, on the Stanford-Binet Intelligence Test, as moderately mentally retarded. Many special educators have objected to the application and usage of the term 'TMH' to children with moderate mental retardation, arguing that such a term is degrading and potentially misleading as to the true educational potential of such individuals. It is acknowledged that the term 'TMH' is not necessarily appropriate for children with moderate mental retardation; however, in order to be consistent with the terms used by Fitness and Amateur Sport Canada, the term 'TMH' will be used in this study to avoid any confusion that may arise when trying to identify the CFA-Adapted program.

CHAPTER TWO

REVIEW OF LITERATURE

Although no universal consensus exists on the various components that make up physical fitness (Campbell, 1973; Moon & Renzaglia, 1982; Reid, Montogemery & Seidl, 1985), most physical fitness tests in use today include some measure of:

1) muscular endurance
2) muscular strength
3) flexibility
4) body composition, and
5) cardiovascular endurance/efficiency.

While all of these components are essential to one's physical fitness, most fitness experts and exercise physiologists have singled out cardiovascular endurance as the component most crucial and essential to overall fitness (Cooper, 1968a; Sheehan, 1975; Fox & Mathews, 1981; Moon & Renzaglia, 1982). This is so because cardiovascular (CV) efficiency is reflected by an individual's ability to (Astrand & Rodahl, 1977; McArdle, Katch & Katch, 1981):

1) utilize the respiratory system to take in oxygen,
2) maximize the delivery of oxygen to the tissues and working muscles via the circulatory system,
3) maximize the utilization of the delivered oxygen at the muscular level to produce energy, and
4) efficiently remove waste by-products (as a result of energy production and expenditure) via the circulatory system.

The importance of CV endurance is also demonstrated by the tremendous amount of research conducted to improve and/or determine this component in the general population as well as in elite athletes.

A review of the research literature on physical fitness evaluation of the MH indicates that the CV endurance of this population has largely gone unexplored or has received very little attention. Numerous studies have investigated the overall fitness of the MH. Only a handful of data-based research, however, has dealt explicitly with the CV fitness of the MH per se.

Over the years, CV fitness evaluation methods and protocols used with elite athletes and the general population have received constant upgrading and investigation. As a result, many of the tests available or in use to-date are often highly precise, reliable, valid, and in some cases, highly sophisticated. The proliferation of many such tests, as evidenced by the wealth of research in the literature, bears this out. Available today is sophisticated equipment that can determine maximal oxygen consumption (VO2 max. - an internationally accepted measure of CV fitness) as an individual exercises on a treadmill or a bicycle ergometer. CV fitness testing with the MH, on the other hand, hardly receives such research "scrutinization". Hence the main CV test used with the MH, the endurance run, has remained practically unchanged over the last 15 years.

To better appreciate the problems and limitations that exist in CV testing of the MH, and understand why the endurance run is such an important CV test for the MH, a discussion and review of the various types of CV fitness tests that have been used with the MH at this point is considered necessary.

CARDIOVASCULAR FITNESS EVALUATION OF THE MENTALLY HANDICAPPED

MAXIMAL AND SUBMAXIMAL LABORATORY TESTS

Maximal and submaximal effort testings on the treadmill or bicycle ergometer are universally accepted as the best methods of determining CV efficiency. Unfortunately such testings of CV fitness in the MHs are few and often plagued with problems and difficulties. To date only two reported studies have attempted to determine the CV fitness of educable mentally handicapped (EMH) subjects using the treadmill (Bar-Or, Skinner, Bergsteinova, Shearburn, Royer, Bell, Haas & Buskirk, 1971; Andrew, Reid, Beck & McDonald, 1979). Studies using trainable mentally handicapped (TMH) subjects in such testing have yet to be reported.

In one of the earliest laboratory testing studies, Bar-Or et al. (1971) reported that 15% of their EMH subjects (N=125), IQ between 50 - 90 on the WISC, were unable to complete a maximal CV test on the treadmill. The reasons cited for non-completion were:

1) refused to walk on treadmill (N=5)
2) refused to complete walk (N=12)
3) refused mouthpiece (N=3)
4) no coordination (ataxia) (N=4)

Despite the 15% of test incompletion, the study found that 6-15 year old boys and girls with IQ ranging from 50-89 have aerobic capacity similar to intellectually normal children. The results, however, could have been inflated because of the absence of data on 15% of the subjects. Two interesting observations were made by the authors :

1) Low IQ may be a contributing factor to incompletion of the maximal test. 21% of those with IQ < 79 did not complete the test compared to 7% of those with IQ > 80.
2) 60% of the subjects living in institutions did not complete the

test compared to 10% of subjects living at home.

In another study that was designed mainly to determine physical trainability of EMH adults (Andrew et al., 1971), the maximal treadmill test was used to measure VO2 max. of the subjects. Although no problems regarding the use of the treadmill test were mentioned, the results of three subjects (two from the control group and one from the experimental group) were missing from the report. No reasons were mentioned for the lack of data on three subjects. It is possible that the subjects either dropped out of the study, or were unable to complete the test.

The major difference between the two mentioned treadmill studies is the amount of time allowed for subjects to be familiar with the test and the testing environment. In Bar-Or et al.'s study, the children were given 2 to 4 minutes of practice prior to actual performance on the treadmill. The children had no previous experience at all with treadmill walking. EMH adults in Andrew et al.'s study were given 2 different practice sessions to be familiar with the treadmill test before being asked to perform maximally on the third session. The time allowed for familiarization with the test and the testing environment is of major concern when testing mentally handicapped subjects. It has generally been shown that the MH, because of the nature of mental retardation, takes a longer time to process information, understand task demands and perform optimally. Wagner (1967) had reported that retarded children require greater incentive to perform well on physical proficiency tests. Most importantly, his study found that EMH subjects need more practice trials and time to achieve maximal performance. His EMH subjects did not reach maximal performance on physical proficiency tests until about the 9th trial and no earlier than the 6th trial. Considering the slower learning and information processing abilities of the MH, it would seem that 2 to 4 minutes of practice on a totally strange test is not sufficient to elicit maximum performance. The percentage of test incompletion in Bar-Or et al.'s study could possibly have been lower if the subjects were allowed more time and practice to get familiar with, and less apprehensive of, the test. Experience has shown that even inexperienced non-MH subjects take quite a while to get used to walking or running on a treadmill with a mouthpiece. Researchers working with the MH need to consider the characteristics of such subjects and design their study accordingly. Testing the MH with procedures and considerations that have been established for the non-MH population is not always appropriate or feasible.

An alternative laboratory procedure for assessing or predicting aerobic capacity is using the bicycle ergometer. Protocols established for such ergometry testing often require that subjects keep a consistent cycling frequency (ie. revolutions per minute, RPM) or pedal at a constant resistance so that the work done can be determined. Such requirements are often problematic when dealing with the MH. In a submaximal ergometry study that investigated the physical capabilities of EMH adults, Nordgren (1970) found that because the MH had considerable difficulties in maintaining a prefixed rate of RPM on mechanically braked bicycle ergometers, electrically braked bicycle ergometers had to be used instead. However, even the "use of electrically braked bicycles did not totally solve this problem because there were some subjects who were still unable to keep the RPM within the limits required for the relevant workload to be determined" (Nordgren, 1970, p. 9). It is disturbing to note that of five studies of ergometry testing of the MH reported to date (Nordgren, 1970; Cummings, Goulding & Baggley, 1971; Maksud & Hamilton, 1974; Coleman, Ayoub & Friedrich, 1976; Andrew et al., 1979), only Nordgren had reported test incompletion (25.4%) and discussed reasons for this problem. Almost all the other studies either neglected this issue or merely accepted it without question. For example, although Cummings et al. were able to exercise moderately MH children with submaximal loads on electrically braked bicycle ergometers, they found that it was not possible to exercise the same subjects maximally; nor was it possible to obtain satisfactory air collections to predict the VO2 max. of this group of subjects. No reasons or explanations were provided or mentioned to explain why this was so.

Maximal performance in all VO2 max. testings is most often terminated due to subjective exhaustion, as indicated by subject's inability or unwillingness to carry on with the test. This criterion for terminating VO2 tests, and hence determination of VO2 max. values, has proved to be confounding in Maksud & Hamilton's study. Significantly, this is the only maximal ergometry test used with MH to be reported in the literature. Maksud & Hamilton suggested that because the MH do not have extensive experience and/or training on riding a bicycle, it is often possible that local fatigue necessitates the termination of the bicycle ergometry test before maximal CV capacities are attained. Shephard (1972) was also of the opinion that when testing non-MH subjects, such local discomfort in the active muscles is responsible for terminating efforts in bicycle ergometer tests. Even though only a submaximal test was used in his study, Nordgren also noticed that there was a discrepancy between the subjective experiences of exhaustion and the often moderate objectively-measured (eg. heart-rate, respiratory frequency and degree of workload) submaximal effort. The problems and discrepancies reported indicate possible confounding of the validity and reliability of such CV fitness testing of the MH. Such confounding makes it difficult to determine whether the results from maximal CV tests reflect maximal CV capacity or the MHs' experience at and/or willingness to tolerate the discomfort and pain of maximal physical exertion. Although maximal CV tests are considered the best procedures for evaluating CV fitness, it is not necessarily the most appropriate or valid method to use with the MH, especially the moderate or severely handicapped.

Instead of maximal CV performance tests, a few ergometry studies have used tests that require submaximal effort performance to estimate the VO2 max. of the MH. Physical work capacity performance at a heart-rate of 170 beats per minute (PWC 170) appears to be the protocol of choice for reported submaximal ergometry studies (Nordgren, 1970; Cummings et al., 1971; Coleman et al., 1976; Andrew et al., 1979, Depauw, Mowatt & Hiles, 1985). Electrically braked bicycle ergometers were used by Nordgren and Cummings et al.; Coleman et al. used a mechanically braked bicycle ergometer; it is not clear what type of ergometer was used in Andrew et al. and Depauw et al.'s study. In Nordgren's study, 33.3% of the women and 20.5% of the men were unable to complete the test. Nordgren suggested that variability in the degree of motivation for physical effort was the most plausible explanation for several of the cases that were terminated due to subjective exhaustion symptoms. Nordgren reported that although the submaximal ergometry test showed considerable varying interindividual capacities, the mean values obtained for physical work capacity on the 47 adult subjects did not deviate essentially from values obtained for non-MH men and women. Like the results obtained by Bar-Or et al., the mean values obtained by Nordgren could have been inflated because of the incompletion cases. In comparison, Coleman et al. reported that their results indicated that the PWC of the adult subjects tested were 20 to 30% below that for non-MH subjects of similar age and sex. However, it must be noted that the subjects used in Coleman et al.'s study were institutionalized EMH and

TMH males. This study is of particular interest and concern because a mechanically braked bicycle ergometer was used with TMH subjects. Considering the difficulties reported by Nordgren, it would be helpful to have some indication of how the researchers managed to get the TMH subjects to keep to the pedalling frequency and work at the three incremental resistance loads. Furthermore, Coleman and his co-workers should have analysed the results of the EMH and TMH subjects separately to determine if there were any possible differences in predicted VO2 max. values between the two groups. Averaging the values obtained across all the subjects makes it difficult to detect any possible intergroup differences between EMH and TMH subjects. Recently, Depauw and co-workers investigated the use of the bicycle ergometer as a comparable CV endurance test for mentally retarded adolescents. The PWC 170 test protocol was used. Results for nine mild to moderately MH subjects tested indicated that the CV endurance levels of these subjects were "very poor".

FIELD TESTS OF CARDIOVASCULAR FITNESS

Many exercise physiologists believe that laboratory tests, like those reviewed so far, can specifically isolate and directly measure the fitness components under study (Docherty & Quinney, 1984). Docherty & Quinney cautioned that field tests do not directly measure the specific fitness components or metabolic capacity. Rather, field tests should more appropriately be referred to as "fitness performance" measures since:

> ... it is the performance that is actually measured, which, it is assumed, is dependent upon a specific metabolic or fitness component (Docherty & Quinney, 1984, p. 16).

It is acknowledged that laboratory tests can, to a certain extent, specifically isolate and measure the desired fitness components under study for elite athletes and/or subjects familiar with the tests and the test demands. However, it is debatable whether the same can be said for the general population and the MH. If CV tests purport to assess or predict CV efficiency, then factors like lack of cognitive appreciation of test demands, apprehensiveness, and low motivational levels will most likely threaten the construct validity of such tests. This is especailly true of the MH, as demonstrated by the laboratory studies reviewed thus far. Field tests may therefore be the better alternatives for testing the MH. Considering the ease of administration, and relatively inexpensive instrumentation needed, it is no wonder that field tests are more popularly used for testing the MH.

The Canadian Home Fitness Test (CHFT)

In a very recent study, the only one to be reported so far, Reid, Montogemery & Seidl (1985) utilized the Canadian Home Fitness Test (CHFT) step test, as part of the Standardized Test of Fitness, to estimate the CV fitness of moderately MH adults in the Montreal area. A total of 105 males and 79 females from five sheltered workshops were studied. Of these 184 subjects, 36 subjects (19.6%) did not complete the CHFT test. The reasons provided for non-completion of the test included:

1. refusal to cooperate (N=15),
2. inability to perform without assistance (N=13), and
3. exceeding the blood pressure criteria for the Standardized Test of Fitness (N=8).

The major problem encountered by the researchers when using the CHFT was that subjects were unable to perform at the stepping sequence tempo appropriate for their age. As such, Reid et al. chose to count the number of ascents performed by each subject per minute and then predicted the maximum oxygen uptake with a regression equation put forth by Jette, Campbell, Mongeon & Routhier (1976). Results indicated that the tested adults' predicted maximum oxygen uptake values ranged between the second and the sixth percentile of the non-MH norms. While it is true that the MH generally have lower CV fitness than the non-MH, it is felt that the results obtained by Reid et al. may be an underestimation of the actual predicted values that the MH are capable of, confounded by the procedures used to estimate maximum oxygen uptake in this study. In counting the number of ascents, and not requiring subjects to step to the required tempo, Reid et al. actually changed the protocol that was established to predict VO2 max.; consequently the validity and reliability established for the CHFT test may not hold for this study. In addition, reliability of the regression equation used has been criticized by other researchers (Ashton, Cohen & Murphy, 1982). Reid and co-workers acknowledged in their report that the regression equation is in need of some refinements. Despite the difficulties encountered in this study, there is, however, much potential in the CHFT as a valid CV test for the MH. Research needs to be conducted to determine the number of trials that the MH need in order to perform the test correctly, and what testing modifications and teaching progression should be used. Like Cummings et al., Reid et al. showed that it was not easy to use a test established for the non-MH. There is therefore a need to have a simple, and yet valid and reliable CV test available for the MH.

The Endurance Run

Since the late 50's, the endurance run has become one of the most widely used field tests of CV endurance. Its popularity stems from the fact that it is an easy test to administer; the time, expertise and equipment needed to conduct the test are minimal; but most of all, running is a simple activity that, presumably, everyone is certain to be familiar with. The testing and introduction of the 12-minute run-walk by Cooper (1968b) confirmed the validity of the test and spearheaded the trend for physical educators to use the endurance run to evaluate CV fitness.

Appreciating the need to have a simple means of testing for CV fitness of the MH population, the American Association for Health, Physical Education and Recreation (AAHPER) was one of the first to use an endurance run to assess the CV endurance of the MH in 1968. Its Canadian counterpart, CAHPER, introduced the endurance run to the TMH in 1983 when the Canada Fitness Award (CFA) was adapted for the TMH. There are, however, many differences between the endurance runs put forth by these two associations. In the AAHPER Special Fitness Test for the mildly MH and the moderately MH, the CV endurance component is determined by a 300-yard (275m) endurance run. The Canadian CFA-Adapted for the TMH, on the other hand, has three different, and longer, distances for three different age groups: 600m for 7-9 year olds, 1,200m for 10-12 year olds, and 2,000m for those 13 years and older.

The AAHPER Endurance Run for the Mentally Handicapped

Originally the AAHPER Youth Fitness Test was designed for the non-MH population. The distance of the AAHPER Youth endurance run was 600 yards. Several investigators (Brace, 1961; Stein, 1965; Sengstock, 1966) have used this run to evaluate the CV fitness of the EMH.

Stein (1965) tested 24 EMH boys with the AAHPER Youth Test in October and the following May. The combined results of the two testing sessions showed that 43.7% of the boys fell below the mean of the national norm for the 600 yard run. Sengstock (1966) compared the performance of EMH boys on the AAHPER Youth test with two groups of non-MH subjects, one group of the same CA and the other of the same MA. Sengstock reported that as a group, the 30 EMH subjects' performance on the 600 yard run was at the 50th percentile of the national norm while the CA-matched normals were at the 68th percentile. There was very little difference between the EMH and MA-matched subjects. It should be noted that in all these studies, there were no reports of test incompletion and/or difficulties related to testing the EMH with the 600 yard run. Studies using the 600 yard run with TMH subjects have yet to be reported.

In 1968, a modification of the AAHPER Youth test was developed by Rarick to make the test valid and usable by the EMH population. Known now as the AAHPER Special Fitness Test, this battery of tests includes a 300 yard run instead of the regular 600 yard. Rarick, Widdop & Broadhead (1970) conducted a pilot study with 4,235 EMH subjects across the United States in 1966 to collect normative data and establish national norms for the Special Fitness Test. According to the authors, the 300 yard run was "long enough to tax the endurance of the retarded children and was not as great a motivational problem" as the longer 600 yard run. EMH performance on the 300 yard run in this study could not be compared to national norms for the Youth test or any other previous studies due to the difference in distance. However some generalities were made by the authors. The performance of EMH boys on the 300 yard run approximately followed the trend of the national results of non-MH on the 600 yard run. That is, the performance curves of the EMH and the non-MH boys were almost linear throughout the age range 8 to 16 years, leveling off in years 17 and 18. On the other hand, the performance curves of the EMH and the non-MH girls were slightly different on the 300 and 600 yard runs respectively. The mean performance of the EMH girls improved sharply between ages 9 and 10, with a modest improvement up to age 13 and a gradual decline thereafter. The AAHPER norm for the non-MH girls showed, however, very slight variations between ages 10 to 17. Rarick et al. concluded that EMH girls on the average improved performance with advancing age up to 12 and 13 years, whereas non-MH girls showed very little change in the preadolescent and adolescent years. As in previous AAHPER studies, no cases of incompletion of the endurance run were reported.

Londeree and Johnson (1974), in an effort to collect normative data, administered the AAHPER Special Test to 606 male and 499 female TMH subjects aged 6 to 9. The results from this study were then compared to the national norms established for the non-MH and EMH populations. This was, and still is, the single most extensive study of TMH subjects' performance on the AAHPER Special Test. Londeree and Johnson noted in their report that many of the subjects did not participate in the 300 yard run. Percentage of subjects who did not participate in the run, compared to the other test items, ranged as high as 43% for the females and 40% for the males. No reasons were given for non-participation. Could it be that subjects refused to participate in the run or were they refused permission to run the 300 yard run by their parents or guardians? Alternatively, did the authors mean that subjects were unable to complete the run when they reported 'non-participation'? It would definitely be very helpful and enlightening if the authors had provided reasons for the reported non-participation. Results from this study demonstrated clearly that overall TMH performance on the Special Test was considerably below that of the EMH and the non-MH. The interquartile channels of TMH performance on the 300 yard did not overlap the EMH or non-MH percentile channels. Also, the TMH interquartile channels for the 300 yard run appeared to be wider than the corresponding channels for the EMH and the non-MH. This finding indicated wider interindividual variability on the run for the TMH. Londeree and Johnson (1974) suggested that possible explanations for the overall subaverage performance of the TMH on the Special Test were:

1) Conceptual complexity of the test items and intellectual loading on the tasks,
2) The excess weight for height and the lack of physical fitness of the TMH, and
3) The little time spent on physical fitness per se during the typical physical education program for MH students.

The Twelve Minute Run

So far, there appears to be only one study that has tried to determined the CV endurance of the MH with a 12-minute walk-run. Depauw, Mowatt & Hiles (1985) attempted to compare the reliability of a bicycle ergometer test with the 12 minute walk-run with nine MH subjects. Results of the subjects' performance on the 12 minute walk-run indicated that their endurance levels were at the 5th percentile of the norms. Interestingly, Depauw and co-workers measured HR responses at every 2-minute intervals and reported that the heart rates reached during the run were higher (in some cases, above predicted maximal HR) and also much more variable.

RELIABILITY AND VALIDITY OF THE AAHPER AND CAHPER ENDURANCE RUNS AS MEASURES OF CARDIOVASCULAR ENDURANCE

Two major considerations when selecting a test battery to evaluate physical fitness, especially for the MH, are that of reliability and validity of the measurement under the normal conditions of administration.

Reliability and Validity of the 600 and 300 yard Runs

Concerns regarding the reliability and/or validity of the endurance runs in the AAHPER Youth Test, the AAHPER Special Test and the initial CAHPER Fitness Performance Test were expressed by several authors (Falls, 1966; Doolittle & Bigbee, 1968; Bolonchuk, 1971; Smith, 1972; Crawford & Mason, 1974; Jackson, 1975; Docherty & Collis, 1976; Speakman, 1977a). The ability of the 600 yard and 300 yard runs to provide an accurate and valid indication of CV fitness was questioned by many of these investigators because of the relatively short distance and the time required to complete the runs. From their investigations conducted with normal subjects, Bolonchuk (1971), Smith (1972) and Jackson (1975) criticized the AAHPER 600 yard run's validity and concluded that the run was a test of muscular and anaerobic work as opposed to aerobic work. In the AAHPER Special Test for the EMH, the norms established for the 300 yard run range from 1:47 min. at the 15th percentile for 8 year old boys to 0:49 min at the 85th percentile for 18 year old boys. Physiologically, the distance and time deemed necessary for completion of the run do not support the claim that 300 yard run is testing CV fitness. It is generally believed, and has been shown by laboratory studies (Astrand & Rodahl, 1977; Fox & Mathews, 1981), that during the onset of any intense exercise, energy for sustaining the exercise during the first 2 to 3 minutes is predominantly supplied by the anaerobic energy system. If EMH subjects are completing the run in such a short time frame, it seems reasonable to argue that the 300 yard run is more of an anaerobic test that taxes the anaerobic lactacid energy system and not the aerobic energy system as claimed.

Falls (1966) and Doolittle & Bigbee (1968) investigated the reliability of the AAHPER 600 yard run as an indicator of CV endurance with normal subjects and reported that the correlation between the 600 yard run and maximum oxygen uptake was 0.64 and 0.62 respectively. Crawford & Mason (1974) and Docherty & Collis (1976) also investigated the reliability of the CAHPER Fitness Performance test with normal subjects in a two-part study and reported some interesting results. The initial reliability coefficient obtained by Crawford & Mason for the 300 yard run was 0.419. In the second part of the study, the authors introduced innovations and variations in the administration of the CAHPER test to raise motivational levels and reported that the reliability coefficient for the run increased to 0.821. This second reliability coefficient value, according to the authors, indicated that the 300 yard run was sufficiently reliable if subjects are motivated to perform. Reliability coefficients were obtained in this study by test-retest comparison of the same test within each part of the study. Raising motivational levels may increase the reliability of the test itself, but it does not necessarily increase the validity of the run as a CV test at all.

Docherty & Collis (1976) correlated 55 non-MH subjects' performance on the CAHPER 300 yard run with the PWC170 test and reported a correlation coefficient of -0.058. The authors concluded that the extremely low correlation indicated that the 300 yard run is "not a valid measure of aerobic capacity but dependent upon speed, and in particular, leg power."

It is evident, as demonstrated by the studies reviewed, that the validity and reliability of the 300 and 600 yard endurance runs as indicators of cardiovascular measures are highly questionable. It was precisely due to such concerns that CAHPER revised the Fitness Performance test and replaced the 300 yard run with longer distances ranging from 800m to 2,400m. CAHPER's professionals were of the opinion that the longer distances are more capable of taxing the CV capacity. It is thus believed that the longer distances are more valid tests of CV endurance. Although investigations to support this claim have yet to be conducted, many eminent physiologists like Astrand & Rodahl (1977), Fox & Mathews (1981), McArdle, Katch & Katch (1981) are also of the opinion that longer distance running is a valid method of assessing CV endurance. Despite the question of validity and reliability, AAHPER is still using the 300 and 600 yard runs as CV endurance tests. AAHPER should, and can, only determine performance on the run per se and not use the runs as CV capacity predictors.

Validity and Reliability of the CFA-Adapted Endurance Run

Considering the numerous problems associated with testing the TMH, whether in the laboratory or in field testing, and the only recent introduction of the CFA-Adapted program, it is not surprising to find that no single study has yet tried to determine the validity and/or reliability of the CFA-Adapted endurance run.

PACING DURING THE ENDURANCE RUN

Outside the laboratory, the endurance run is used routinely to assess CV fitness. Endurance runs are based on:

- ... the reasonable notion that the distance one is able to run in a specified time (in excess of 5 or 6 minutes) is determined by the ability to maintain a high steady rate level of oxygen consumption (McArdle et al., 1981, p. 145).

Although the endurance run has been shown to be a reasonable predictor of CV fitness, the influence and confounding of a self-selected pace upon performance have often been overlooked. Katch et al. (1973) have proposed that endurance runs are uncontrolled exercise tests where subjects may be performing in a manner inconsistent with their true CV capacity because of pacing errors during the run. Corbin (1973) was especially critical of the ability of the endurance run as a measure of CV fitness for children because he felt that most children have an inadequately developed concept of pacing. Adequate or proper pacing, he believed, can make the difference between good and poor performance on the endurance run. Katch and co-workers (1973) summed up aptly when they commented that:

> ..although performances such as... various running events have been used as tests of endurance, interpretation of results is difficult because of certain problems inherent with the particular test procedures. In an endurance running test, for example, what should be the proper starting pace so that some individuals do not begin running too fast so they are forced to slow down because of the accumulation of a large lactate debt? Other individuals might begin too slowly (and continue that way) so that their final performance score may not reflect their true endurance capacity. In this framework, the Cooper 12-minute running test neglects the need to establish effective pacing for inexperienced subjects.

The validity of the endurance run is therefore highly questionable when trainable mentally handicapped children and youths are tested because experience has shown that such individuals often do not have any appreciation for the concept of pacing.

MOTIVATION AND PHYSICAL DIFFICULTY OF THE ENDURANCE RUN

While researchers concerned themselves mainly with evaluating the performance of the EMH and TMH populations on the 300 and 600 yard runs, and comparing these performances with the national norms for the non-MH, Speakman (1977a) should be commended for looking beyond these concerns. Speakman was of the opinion that when physical fitness tests designed for the non-MH population are used to measure the fitness of the MH population, there are three major areas of difficulties that the MH may experience:

1) The test items may be physically too difficult for the MH to perform,

2) The test items may be motivationally too demanding, and

3) The test items may be too complicated for the MH.

Fait and Kupferer (1956) have provided substantial evidence to support Speakman's concern that fitness test items may be too complex that MH children cannot produce maximal effort. Their study of 4? EMH boys' performance on two motor tasks, the vertical jump and the squat thrust, showed that results from the vertical jump were favourable when compared to those of the non-MH whereas the squat thrust performance was significantly lower than the results of the non-MH population. Fait and Kupferer concluded that the differences were influenced by the complexity of the movements involved in performing the squat thrust than to basic differences in motor and fitness abilities. There were no other studies that dealt with issues of test difficulty when testing the MH.

In an attempt to answer his own concerns, Speakman (1977b) designed a study to investigate the suitability of the Hayden Fitness Test items for the MH. The test items were evaluated to see if they were physically too difficult, motivationally too demanding and for degree of complexity. The 300 yard run was one of the eight test items investigated. The other items were : flexed arm hang, medicine ball throw, back extension flexibility, speed back lifts, speed sit ups, vertical jump, and floor touch flexibility. It was found that the 300 yard run was the most motivationally demanding test item. Unfortunately, despite his good intentions and well considered concerns, Speakman's study was too dependent upon poorly defined subjective criteria when he attempted to identify the three difficulty areas. For example:

> ... the decision as to whether an item was too physically difficult was made firstly after the tester had determined that the subject understood the correct performance of the item and, secondly, after the subject had attempted to perform the item. If there were a number of subjects who understood the correct performance of the item, yet were unable to perform it, the decision would be made that the item was too physically difficult (Speakman, 1977b, p.32).

The lack of well-defined constructs and objective criteria to assess the degree of the suggested difficulty areas made Speakman's study a weak one in this respect. However Speakman's study posed the challenge that no study has yet taken, that is, can we determine objectively and accurately whether physical fitness test items are physically (ie. physiologically) and motivationally too demanding for the EMH and the TMH? The degree of physiological difficulty involved in the endurance run is of particular interest since it has been reported that many TMH children and youth are unable to complete the run. An extensive search through the literature has failed to produce any studies related to investigation of the physiological demands of the endurance run upon MH and non-MH children and youth.

HEART RATE AS A MEASURE OF CARDIOVASCULAR FITNESS AND EXERCISE INTENSITY

The exercise intensity that an individual works at can be determined by direct oxygen consumption measurements or by the changes in heart rate responses measured during the activity. Direct measurements of oxygen consumption during exercise involve extensive laboratory facilities, equipment and expertise, as well as considerable motivation on the part of subjects. Such testings are potentially risky and not suitable for inexperienced and untrained subjects (McArdle et al., 1981). Consequently, HR measures are often used to estimate exercise intensity or circulatory capacity (Astrand & Rodahl, 1977; Fox and Mathews, 1981). Many studies have shown that the changes in the measured HR correspond to the changes in the intensity of exercise (Astrand & Ryhming, 1954; Malhotra, Gupta & Rai,1963; McArdle et al., 1981). Heart rate response measurements during exercise are thus by far the simplest and most extensive measures utilized for evaluating CV capacity.

It has been shown that HR increases linearly with increasing workloads or VO2 in both trained and untrained subjects (Fox & Mathews, 1981). The higher the exercise intensity, the greater the HR response. The rationale for using HR as an estimation of exercise intensity is therefore based on this linear relationship that has been shown to exist between HR and oxygen consumption in submaximal type of exercise tests (Astrand & Ryhming, 1954). Some studies have suggested that this linear relationship holds true only for HR up to about 170 beats per minute, beyond which the relationship tends to be asymptotic. It should be noted that this linear relationship was often tested and verified with adult subjects and rarely with children. A bicycle ergometry test conducted by Cummings & Danzuger (1963) to determine the correlation of pulse rate with oxygen consumption in children found that the pulse rate method of determining working capacity in children is a valid one. Metz and Alexander (1971) have also shown that HR during submaximal work is significantly related to maximal oxygen intake for 12-15 year old boys.

CHAPTER THREE

METHODS AND PROCEDURES

THE SCHOOLS

The sample under study was selected from three schools in the Edmonton Catholic School System. Co-operation from the schools was obtained 4-6 weeks before actual testing began. In each of these schools, there were two classes designated for TMH students, with class size ranging from 6 to 10 students. None of the three schools had ever used the CFA-Adapted format with the students before. The purpose of the study and testing procedures was explained to the teachers during the initial meetings. Concerns and questions that the teachers had were attended to before accompanying letters and consent forms for participation (See Appendix C) were delivered to the respective schools. Teachers were requested to explain the study as carefully as possible to parents and if the need was there, to contact the tester. All consent forms were collected from the respective schools before testing began.

School A

Students from this school had been very active during the 4 to 6 months prior to this study. The students were involved in a research project that introduced them to skiing during November - February, pool canoeing from March - April and biking from June - July. Also, some students served as subjects for a pilot study of the present study in late March. During the pilot study only two testing sessions were conducted. Subjects from this particular school were very familiar with the tester due to the numerous contacts they had through the various activities.

Consent for participation was obtained from all subjects selected from this school.

School B

Students from this school were the least verbal. Those subjects in the 13 and older age group were all non-verbal but responded well to instructions. Consent for participation for two students was not given by their parents. Physical activities provided for the students included PE classes, swimming and horse-back riding.

School C

All of the TMH students from School C were between 10 to 12 years old. All subjects selected were given permission to participate. The students were very verbal and encouraged each other well during the testing runs. Regular PE classes, swimming and outdoor activities were part of the students' program in school.

THE SAMPLE

For clarity of results, it was decided that only those students who did not display any physical handicaps would be selected. Children suffering from any cardiovascular disease(s) and/or seizures were also excluded. The selection criteria were used to avoid any possible confounding of the results that may be attributed to any of the mentioned factors. In addition, only those subjects who had parental consent to participate were used.

A total of 24 TMH students, 18 males and 6 females were involved in the study initially. However one female subject had to be excluded from the study when she moved to B.C. after the second testing session. Male and female subjects in the 10-12 year old age group were grouped and tested together as a group. The breakdown of the sample according to age, sex and school is shown in Table 1.

Initially a sex and age grouping of subjects was proposed in the design of the study. However, due to the lack of subjects available in the 10-12 age group, it was decided to group all the available subjects in that age group, males and females, and test them as a group.

EXPERIMENTAL DESIGN OF THE STUDY

The study consisted of five consecutive weeks of testings from May to June. Each subject was tested once per week. The first testing session of the endurance run was a pretest using the current CFA-Adapted test protocol. Following the pretest, subjects were grouped and assigned to either Experimental or Control conditions.

Experimental Group

Subjects assigned to the experimental condition ran with pacer-prompters at specified paces during the 2nd (T1), 3rd (T2) and 4th (T3) testing sessions. During these three treatment sessions, the proposed pacing protocol was utilized.

Control Group

During the three treatment sessions of the study, control subjects ran the endurance run according to the current test protocol as in pretest. That is, control subjects ran independently without pacer-prompters throughout the five testing sessions. For the final testing session on the 5th week, all subjects in the same age group, whether experimental or control, were randomly assigned to run the endurance run, three subjects per trial. The current CFA-Adapted test protocol was used in the final testing, Table 2 shows the experimental design used in the study.

Table 1

Subjects grouped according to Age, Sex and School.

School	10-12 Year Olds		13 Years and older
	Males	Females	Males
School A	1	1	7
School B	2	2	3
School C	5	3	-
Total	8	6	10

Table 2

Experimental Design of Study.

	PRE-TEST	T1	T2	T3	POST-TEST
EXPERIMENTAL GROUP	CFA CURRENT		CFA PROPOSED		CFA CURRENT
CONTROL GROUP	CFA CURRENT		CFA CURRENT		CFA CURRENT

ASSIGNMENT OF SUBJECTS TO TREATMENT CONDITIONS

Subjects in a specific age group were rank-ordered according to their pretest performance on the CFA-Adapted endurance run and then assigned to either experimental or control condition. The rank-ordering of subjects was based on 2 criteria:

1) for those subjects who were able to complete the run within the set criterion time of the CFA-Adapted protocol, the time taken to complete the required distance was the dependent variable used for ranking.
2) for those subjects who were unable to complete the run, the total distance covered/completed was the other dependent variable used for ranking. All subjects ranked in this manner were then ranked behind those who completed the run.

After all subjects were rank-ordered, sub-groups of three subjects were made. Subjects were then assigned to either experimental or control condition according to the following procedures:

RANK-ORDER OF SUBJECTS	TREATMENT CONDITION
1	CONTROL
2	EXPERIMENTAL
3	EXPERIMENTAL
4	EXPERIMENTAL
5	CONTROL
6	EXPERIMENTAL
7	EXPERIMENTAL
8	EXPERIMENTAL
9	CONTROL
10	EXPERIMENTAL
11	CONTROL
12	EXPERIMENTAL

JUSTIFICATION OF ASSIGMENT PROCEDURES

Random assigment of subjects to either experimental or control conditions has generally been the method advocated by researchers to avoid selection bias and allow for representativeness of the sample under study. However because of the small sample size involved in this study and the nature of the dependent variables being measured, there is a high possibility that random selection would not necessarily allow for representativeness of subjects in both experimental and control conditions. The rank-ordering and systematic sub-grouping method was therefore used to ensure that subjects with varying performance levels were present in both the experimental and control group. This made it possible to determine whether changes in performance variables during the treatment sessions were in the same direction or otherwise for subjects within each treatment condition and across conditions.

SUB-EXPERIMENTAL GROUPING

Based on their pretest performance, experimental subjects ran at different pacing times during the treatment sessions. To arrive at an appropriate pacing time for each subject, subjects assigned to the experimental condition were systematically grouped, according to their pretest performance, into the following sub-experimental group. The grouping was based on the 4 award levels of the CFA, that is, Bronze, Silver, Gold and Excellence.

10-12 year olds

Group A1 - those who cannot complete 600m

Group B1 - those who completed 600m but not 1,200m

Group C1 - those who completed the 1,200m at/below the Bronze level

Group D1 - those who completed the 1,200m at the Silver level

Group E1 - those who completed the 1,200m at the Gold level

Group F1 - those who completed the 1,200 at the Excellence level

13 Year olds and above

Group A2 - those who cannot complete 1,000m

Group B2 - those who completed 1,000m but not 2,000m

Group C2 - those who completed the 2,000m at/below the Bronze level

Group D2 - those who completed the 2,000m at the Silver level

Group E2 - those who completed the 2,000m at the Gold level

Group F2 - those who completed the 2,000m at the Excellence level

Pacing times for the sub-groups were determined based on award times at each award level, with the pace for each group of experimental subjects being set at the next fastest time. For example, subjects who completed the pretest at the Silver level (Group D2) were paced at the Gold level on the first treatment session. However for those who completed at the Excellence level, pacing times were generally 1 minute faster than pretest time. (See Appendix D for actual pace times). Experimental subjects who were able to complete the run at the set pace or better during the treatment sessions were then paced at the next faster pace on the subsequent treatment session. Those who were unable to meet the pre-determined pace during treatment sessions were paced at the same pace on subsequent runs.

COMPUTATION OF PACE TIME FOR EACH 100m MARK

In the proposed protocol, two pace-keepers were utilized at each 100m mark to keep the pacer-prompters at the right running pace. The pace-keepers had pace cards with the time computed for each 100m and had to count down the last 10 seconds of the specific time computed.

To arrive at the time for each 100m, about 10 seconds were deducted from each individual award time and the result divided by the number of 100m (See Appendix E). That is, the deducted time for each 10-12 year old award level was divided by 12 (1,200m). For the 13 and older group, it was divided by 20 (2,000m). About 10 seconds were deducted from each award time because it was rationalized that since the experimental subjects had to keep behind the pacer- prompters, the pacer-prompters therefore had to be running a little faster than the award times. Also, each 100m time was rounded off to the nearest second.

COLLECTION OF HEART RATE DATA

Heart-rate responses, in beats per minute, were averaged over every 30 second interval by the Sport-testers during the run and stored in the memory function of the Sport-tester's microcomputer. A total of four Sport-testers were used. The four Sport-testers were validated with ECG readings of a selected subject's performance on the treadmill. HR collected by the Sport-testers were generally ± 2 beats per minute slower or faster than those obtained by ECG readings. Karvonen, Chwalbinska-Moneta & Saynäjäkangas (1984) haved compared heart-rates measured by ECG and Sport-tester microcomputers and reported that the mean value of heart-rates obtained by both methods differed at most by ± 5 beats per minute.

TESTING PROCEDURES

All testing sessions were conducted in the University of Alberta Universiade Pavilion running track. This 200m indoor running track was closed to all other university users during the testing sessions to avoid any interference or distractions. Sport-testers used to monitor and collect heart-rate data were cleaned and checked prior to all testings. Digital stop watches were used for timing and pacing.

Subjects involved in the study came to the Universiade Pavilion once a week for the five consecutive weeks. All testings were conducted in the mornings.

Pre-test

The CFA-Adapted endurance run was conducted according to the current testing protocol during the first testing session. A maximum of 3 subjects in the same age category were tested together per trial. Each subject wore a Sport-tester during the run.

Treatment sessions (Week 2 - 4)

Subjects in the experimental group were tested separately from the control group. Experimental subjects ran the required distance with pacer-prompters setting the pre-determined paces. A maximum of three subjects running at the same pace were tested at any one time. A minimum of two time-keepers were used per trial.

Subjects in the control group were tested as in the pretest.

Post-test

During the post test, all subjects of the same age group, whether experimental or control, were randomly assigned to run together. A maximum of three subjects were tested for any one trial. The current testing protocol of the CFA-Adapted run was used in the post-test.

ANALYSIS OF DATA

Times taken by the subjects to complete the run were tabulated for all the testing sessions so as to allow for comparison of performance across sessions. Award levels achieved for each run were also tabulated to determine if there were any changes in the levels achieved.

In order to understand the heart rate data, the heart-rates (in beats per minute) averaged over every 30 seconds of the run were organised into the following heart-rate intervals:

$\leqslant$ 100 bpm - resting (Marshall, 1981)

101 - 119 bpm - mild

120 - 139 bpm - high mild (Marshall, 1983)

140 - 159 bpm - moderate/high moderate (Chausow et al., 1984)

160 - 179 bpm - vigorous (Gilliam et al., 1981)

180 - 199 bpm - severe (Gilliam et al., 1981)

≥ 200 bpm - extremely severe (Astrand & Rodahl, 1977)

Frequency counts of heart-rates in the intervals were then made for each testing session for each subject. From the frequency counts, percentage distribution of HR data points in each interval was computed.

Since not all subjects were able to complete the run or achieve an award level, there were therefore some indefinite scores. In addition, heart-rate data points for some subjects at different testing sessions were also lost when subjects accidently or intentionally touched the sport-tester recorder control buttons. As a result, it was impossible to perform statistical tests to determine if there were any significant differences in performance or HR response between control and experimental subjects across the testing sessions.

CHAPTER FOUR

RESULTS

It became apparent during analysis of the data that the two age groups tested had to be examined separately because of the difference in the running distance. Since similarities and/or differences in performance trend and response to the proposed pacing protocol were noted between the two age groups, comparison of overall performance and heart-rate (HR) responses between the two groups will therefore be made throughout the discussion of the results.

Performance of subjects on the run during the five testing sessions will be examined in the first part of this chapter. The second section will present the findings of physiological responses to the run as indicated by HR. Finally, an attempt will also be made to highlight and discuss cases of individual subjects with unique performance changes and/or responses to the run.

PROFILE OF SUBJECTS

Tables 3 and 4 present the age, sex and pretest times of subjects ranked according to pretest performance in each age group. Mean age of the 10-12 year old group is 11.8; mean age of the 13-and-older boys is 16.0. In the 10-12 year old group, boys and girls were distributed fairly evenly at different positions on the rank-order. Performance of girls on the CFA-Adapted run was comparable to the boys.

Table 3

Sex, Age and Pretest Times of 10-12 year old subjects

SUBJECT	SEX	AGE	PRETEST TIME
EXPERIMENTAL SUBJECTS			
SE1	F	11.7	6:12 min
SE2	M	12.1	6:15 min
SE3	M	12.1	6:48 min
SE4	F	12.8	8:41 min
SE5	M	11.5	8:58 min
SE6	M	10.7	11:01 min
SE7	F	12.5	11:10 min
SE8	M	11.5	INCOMPLETE
SE9	F	11.3	INCOMPLETE
CONTROL SUBJECTS			
SC1	M	12.1	5:55 min
SC2	M	11.9	8:08 min
SC3	M	10.0	8:17 min
SC4	F	12.9	11:10 min

Table 4

Age and Pretest Times of 13-and-older subjects

SUBJECT	SEX	AGE	PRETEST TIME
EXPERIMENTAL SUBJECTS			
SE10	M	14.7	12:48 min
SE11	M	14.5	13:00 min
SE12	M	16.2	16:55 min
SE13	M	15.6	INCOMPLETE
SE14	M	16.0	INCOMPLETE
SE15	M	17.4	INCOMPLETE
SE16	M	16.4	INCOMPLETE
CONTROL SUBJECTS			
SC5	M	16.5	12:35 min
SC6	M	17.1	17:13 min
SC7	M	15.8	INCOMPLETE

PERFORMANCE ON THE CFA-ADAPTED RUN

COMPLETION RATES ON THE CFA-ADAPTED ENDURANCE RUN

10-12 Year Old Group

Data obtained from 705 10-12 year old TMH children tested across Canada indicated that only about 17.20% of these were able to complete the 1,200m endurance run (See Appendix A). In this study 11 out of 13 tested subjects were able to complete the same run with the recommended test protocol. This represents an 84.62% completion rate, demonstrating a sharp difference in completion between the tested sample and the reported national data. However, one needs to keep in mind the large difference in number of subjects tested by both studies. Percent completion figures computed are based on the proportion of those subjects who completed the run versus those who did not; therefore each subject in a small sample contributes more, porportionally, to the computation of percent completion. Obviously, percent completion obtained in each study is thus affected tremendously by the sample size tested.

If Subject SE6's incompletion of the run due to a fall during T2 is disregarded, a 100% completion was achieved by both experimental and control subjects for the three treatment (T) sessions and the posttest. Table 5 shows the percent completion rate for both age groups.

The two incomplete pretest cases, Subject SE8 and SE9, were assigned to the experimental condition and were able to complete the 1,200m during T and posttest sessions. That is, completion of the run was achieved by SE8 and SE9 when pacer-prompters were used during T1-T3 and this carried over to the posttest even when the pacer-prompters were removed. Within the limits of the small sample size used in this study, the proposed pacing protocol was therefore able to increase the proportion of 10-12

Table 5

Percentage of completion on the CFA-Adapted endurance run

	Percentage of Completion				
	Pretest	T1	T2	T3	Posttest
10-12 YEAR OLDS					
EXPERIMENTAL	77.78	100.0	100.0	100.0	100.0
CONTROL	100.0	100.0	100.0	100.0	100.0
OVERALL TOTAL	84.62	100.0	100.0	100.0	100.0
13-AND-OLDER					
EXPERIMENTAL	42.86	66.67	66.67	66.67	71.43
CONTROL	66.67	66.67	66.67	33.33	50.0
OVERALL TOTAL	50.00	66.67	70.00	70.00	66.67

year old TMH children who can complete the run as hypothesized in Hypothesis #1.

13-and-Older Group

As a group, 5 out of 10 subjects were unable to complete the 2,000m run during the pretest. This represents a 50% completion rate compared to 11.65% completion reported for 1,253 13-and-older TMH males tested across Canada. This represents a 35.35% difference in completion rate between subjects tested in this study and the national group.

Of the five incompletion cases obtained during pretest, four were assigned to the experimental condition while one was assigned to control condition. By T3, only one experimental subject, SE16, was still unable to complete the run with a pacer-prompter. Three of the initial incompletion cases were able to complete the distance with pacer- prompters by T3. From a 42.86% completion at pretest, the experimental group achieved a high of 85.71% completion at T3 and a slight decrease to 71.43% at posttest (Table 5). As with the 10-12 age group, the high completion percentage at T3 provides support for Hypothesis #1 - that the proposed pacing protocol can increase the proportion of TMH subjects who can complete the endurance run. The highest completion rate achieved by the control group was 66.67%.

Two of the experimental subjects, SE13 and SE15, who were unable to complete the run independently at pretest were able to do so at posttest. The one control subject who did not complete the run at pretest never did complete the run at any of the testing sessions.

TIME TAKEN TO COMPLETE THE RUN

10-12 Year Olds

The times taken by each subject to complete the run and the award level achieved for each of the five testing sessions are shown in Tables 6 and 7. The best time achieved by each subject during the T sessions is also indicated in the table. The Mean-T-time over the three T sessions is also computed for each subject to try and provide a more representative indication of overall mean performance during T sessions. It must be remembered that the variability in T session performance for some subjects could have been caused by the change of pacing times within the T sessions. Of the nine experimental subjects, three changed to a faster pace by one level while pacing times for subjects SE8 and SE9 changed by 3 and 2 levels respectively (See Appendix F).

If the Best-T-time is taken to represent each subject's best or maximal performance, all experimental subjects showed improvements in the time taken to complete the run during T sessions when compared to pretest performance. This represents a 100% improved performance for the experimental group during T sessions. Two out of 4 control subjects (ie. 50%) had better Best-T-times than pretest times.

Seven out of the 9 experimental subjects had better performance times when the Mean-T-time is compared to pretest time. This represents an improved performance of 77.78% when the proposed pacing protocol was used. In comparison, only 1 control subject (ie. 25%) had a better Mean-T-time than pretest time. Regardless of whether Best-T-time or Mean-T-time is used to compare pretest and T performances, there appears to be a general trend of better performance by experimental subjects when the pacing protocol was used. This lends support to Hypothesis #2 which predicted

Table 6

Time taken (min.) by 10-12 year old subject to complete 1,200m

SUBJECTS	PRETEST	T1	T2	T3	MEAN-T-TIME	POSTTEST
EXPERIMENTAL						
SE1	6:12	7:06	ABS.	*5:59	6:33	7:25
SE2	6:15	6:13	6:17	*6:04	6:11	6:02
SE3	6:48	*6:21	6:52	ABS	6:37	7:40
SE4	8:41	ABS	*7:59	8:09	8:04	8:15
SE5	8:58	*8:30	10:00	9:50	9:26	9:57
SE6	11:01	*10:05	FALL	ABS	10:05	10:55
SE7	11:10	*10:14	10:25	10:49	10:29	11:08
SE8	INC	10:24	9:52	*9:39	9:58	9:39
SE9	INC	*11:24	11:48	11:40	11:37	12:17
CONTROL						
SC1	5:55	*5:39	5:39	5:49	5:42	5:47
SC2	8:08	9:03	8:52	*8:14	8:43	10:53
SC3	8:17	10:36	ABS	*10:09	10:22	12:39
SC4	11:10	*10:29	11:59	12:37	11:42	11:37

* : BEST-T-TIME

INC : INCOMPLETE

ABS : ABSENT

Table 7

Award levels achieved by 10-12 year old subjects

SUBJECTS	PRETEST	T1	T2	T3	MEAN-T-TIME	POSTTEST
EXPERIMENTAL						
SE1	E	E	ABS	E	E	G
SE2	E	E	E	E	E	E
SE3	E	E	E	ABS	E	E
SE4	S	ABS	G	G	G	S
SE5	S	G	B	S	S	B
SE6	B	B	-	ABS	B	B
SE7	NA	B	B	NA	NA	NA
SE8	INC	B	B	S	B	S
SE9	INC	NA	NA	NA	NA	NA
CONTROL						
SC1	E	E	E	E	E	E
SC2	E	S	G	G	G	B
SC3	G	B	ABS	S	B	NA
SC4	NA	NA	NA	NA	NA	NA

AWARD LEVELS

E - Excellent
G - Gold
S - Silver
B - Bronze

NA - No award level achieved
ABS - Absent
INC - Incomplete

that the use of systematic pacing with pacer-prompters can improve the performance of TMH children on the CFA-Adapted run.

It should also be pointed out that those experimental subjects who improved most significantly during the T sessions were those who were ranked lowest in the group.

When comparing pretest to Best-T-time performance, subjects ranked 1st and 2nd in the experimental group improved by 0:13 min. and 0:11 min. respectively. In comparison, those subjects ranked 3rd to 7th improved as much as 0:27 min. to 0:55 min. Subject ranked 8th, SE8, improved from an 'incomplete' to a silver award time. A similar general pattern in the performance changes by experimental subjects was also noted if pretest is compared with Mean-T-time. There appeared to be a possible ceiling effect for the two faster runners, which may therefore have masked or 'concealed' any effect that pacing may have upon these two subjects. The proposed pacing protocol was therefore more effective with the slower experimental subjects. No such trend in performance changes from pretest to T sessions was exhibited by the control group. Changes in performance for the control group were more random and in no specific direction.

An interesting observation is made that for five experimental subjects, the Best-T-time was achieved during the first T session (Subject SE4's T2 performance is considered a T1 performance due to subject's absence during T1). Such an observation might suggest that in general, there is no need for more than one pacing trial to obtain best performance <u>if</u> the subsequent pacing is appropriately based on each subject's pretest performance.

Hypothesis #3 speculated that experimental subjects' performance during posttest would be worse than T sessions' performance while control subjects should have little variability in performance time across testing sessions. Posttest results indicated that this hypothesis cannot be accepted. Seven out of 9 experimental subjects did worse for posttest when their Best-T-time is compared to posttest; one subject had the same performance for Best-T-time and posttest, while another subject improved on posttest by 0.02 min. Contrary to speculation, all control subjects did worse on posttest when compared to Best-T-time. When the Mean-T- time is compared to posttest, the same seven experimental subjects did worse again. One control subject did better on the posttest. It thus appears that for the majority of the 10-12 year old subjects, experimental and control, the trend is for posttest performances to be worse than T session performances.

Award level changes achieved by subjects during the different testing sessions are indicated in Table 7. No award level changes were possible for the three fastest experimental runners and the fastest control runner as they were already at the 'Excellent' award level. Three experimental subjects achieved better award levels during T sessions than pretest. One experimental subject had a lower award level for T session performance; two control subjects also had lower award levels during T sessions. A total of 11 subjects out of 13 managed to achieve at least one award level during this study.

13 and older group

Tables 8 and 9 show the time taken to complete the 2,000m and the award level achieved by the 13-and-older males for the five testing sessions. Based on Best-T-times, all but one experimental subject had better performances when the T sessions were compared to Pretest. Subject SE11 and SE12 improved on their pretest times by 0.13 min and 5.33 min respectively; subject SE13, SE14 and SE15 did not complete the pretest,

Table 8

Time taken (min.) by 13-and-older subjects to complete 2,000m

SUBJECTS	PRETEST	T1	T2	T3	MEAN-T-TIME	POSTTEST
EXPERIMENTAL						
SE10	12:48	*12:57	12:59	12:57	12:58	13:23
SE11	13:00	13:58	*12:47	14:21	13:42	15:07
SE12	16:55	13:47	12:21	*11:22	12:30	12:31
SE13	INC	*18:04	19:32	18:56	18:50	18:59
SE14	INC	ABS	*18:50	20:07	19:28	INC
SE15	INC	INC	INC	*15:03	15:03	15:46
SE16	INC	INC	INC	INC	INC	INC
CONTROL						
SC5	12:35	12:51	*12:30	14:38	13:20	12:47
SC6	17:13	19:35	*16:15	INC	17:55	ABS
SC7	INC	INC	INC	INC	INC	INC

* : BEST-T-TIME

INC : INCOMPLETE

ABS : ABSENT

Table 9

Award levels achieved by 13-and-older subjects

SUBJECTS	PRETEST	T1	T2	T3	MEAN-T-TIME	POSTTEST
EXPERIMENTAL						
SE10	S	S	S	S	S	B
SE11	S	B	S	B	B	NA
SE12	NA	B	S	G	S	S
SE13	INC	NA	NA	NA	NA	NA
SE14	INC	ABS	NA	NA	NA	INC
SE15	INC	INC	INC	NA	NA	NA
SE16	INC	INC	INC	INC	INC	INC
CONTROL						
SC5	S	S	S	B	B	S
SC6	NA	NA	NA	INC	NA	ABS
SC7	INC	INC	INC	INC	INC	INC

AWARD LEVELS

E - Excellent
G - Gold
S - Silver
B - Bronze

NA - No award level achieved
ABS - Absent
INC - Incomplete

making it impossible to obtain time performance differences between pretest and T sessions. Although subject SE16 did not complete the run for any T sessions, he managed to complete 500m more during T sessions than pretest. Two control subjects also had better Best-T-time than pretest. If Best-T- time is therefore used as an indication of performance potential, there were improvements by both experimental and control subjects during the T sessions. Unlike the 10-12 year old group, it is very difficult to determine whether the pacing protocol used was, in fact, effective since control subjects also improved their performance without pacer-prompters.

When Mean-T-time is used to compare pretest with T sessions, four experimental subjects (57.14%) had better Mean-T-times than pretest time. The other three experimental subjects did not complete the pretest, so no time comparisons could be made. None of the control subjects did better during the T sessions if Mean-T-time is compared to pretest time. Mean-T-times do provide some support that the proposed pacing protocol was effective in improving performance, but the significance of this effectiveness cannot be determined. Better performances by experimental subjects during T sessions do provide support for Hypothesis #2.

Interestingly, those experimental subjects who were ranked lower in the group were the ones who had improved T performances. This phenomenon was also observed in the younger subjects. The systematic pacing protocol was certainly very effective in improving subject SE12 and SE15's performances. Subject SE12 improved as much as 5.33 min and 4.25 min when Best-T-time and Mean-T-time are respectively compared to pretest. From a 'No' award time at pretest, subject SE12 went on to achieve a 'Gold' award level at T3. Subject SE15, who managed to complete only 1,200m during pretest, completed the 2,000m within criterion times but missed the bronze level by 0.18 min during T3. On the other hand, subjects SE10 and SE11, the two fastest experimental runners during pretest, showed little or no improvements during T sessions. It is possible that a ceiling effect was being observed for these two subjects.

Best-T-times were observed to be achieved predominantly during T1 by the 10-12 year old group. In contrast, no such trend was observed for the older males. Best-T-times were distributed evenly over the three T sessions.

Posttest performance of all experimental subjects was worse than T sessions. The decline in performance during posttest ranged from 0.26 min to 2.20 min if the posttest time is compared to Best-T-times. Time differences between Mean-T-time and posttest time ranged from 0.01 min to 1.25 min. Subject SE14 was able to complete the run with a pacer-prompter during T2 and T3 but failed to do so independently during posttest. The absence of pacing during posttest seemed to affect performance adversely. One control subject also did worse during posttest while another control subject never did complete the run at any testing sessions. One control subject was absent during posttest. There was therefore hardly any support for Hypothesis #3 although experimental subjects' posttests were generally worse.

The difficulty of comparing pretest and posttest results for this group is caused by incomplete runs at pretest and posttest. Of the five experimental subjects who completed the posttest, two subjects (SE10 and SE11) do worse on the posttest; subject SE13 do better on the posttest than pre-test by 4.24 min, while it is impossible to compare the other two subjects due to incomplete pretest runs. Two experimental subjects did not complete the run at posttest. Of the two control subjects who ran during posttest, SC5 had a worse posttest time than pretest; subject SC7 did not complete the run.

Based on pretest times, only 2 out of 7 experimental subjects were able to achieve award levels (See Table 9). One control subject also managed to achieve an award level. Very little award level changes took place during the T sessions. Only one experimental subject was able to go from a 'No' award at pretest to a 'Gold' award during T3. Number of awards achieved by control subjects also remained unchanged throughout T sessions. Number of posttest awards was also similar to pretest.

HEART RATE RESPONSE PATTERNS

HEART-RATE DATA POINT PERCENTAGES

10-12 Year Old Group

Percentages of heart-rate (HR) data points in each of the seven HR intervals were calculated for the two age groups. The data for the 10-12 year olds is shown in Table 10. Figure 1 is a graphical representation of the response pattern of the data points for HR $\geq$ 160 beats per minute (bpm) and HR $\geq$ 200 bpm. All HR data points greater than or equal to 160 bpm are categorized as being in and beyond the vigorous intensity level.

Figure 1 shows that except for the control group at posttest, more than 80.0% of the HR data points (HR-DP) were greater than or equal to 160 bpm throughout the five testing sessions. On the average, HR-DP greater than or equal to 160 bpm ranged between 83.0% to 92.0%, with the exception of 48.86% computed for the control group at posttest. HR-DP of 10-12 year old TMH children in this study were therefore at vigorous to severe intensity levels for about 83.0% to 92.0% of the time during the endurance run. Data on HR responses therefore do not provide any support for Hypothesis #4. TMH subjects were not working at low to mild intensities; rather the subjects were working at vigorous to severe intensities regardless of whether the current or proposed protocol was used. Pretest

Table 10

Percentage of heart rate data points in the 7 HR intervals
(10-12 year old group)

HR INTERVAL	PRETEST		T1		T2		T3		POSTTEST	
	E	C	E	C	E	C	E	C	E	C
≤ 100 bpm	3.54	-	0.81	-	1.92	-	2.22	1.72	3.35	-
101 - 119	1.77	6.85	3.25	4.69	2.88	3.51	2.22	-	2.79	7.95
120 - 139	5.31	-	2.44	3.13	1.92	1.75	0.74	1.72	0.56	21.59
140 - 159	6.19	2.74	1.63	9.38	8.65	10.53	11.11	1.72	10.06	21.59
160 - 179	34.51	38.36	30.08	46.88	42.31	43.86	41.48	27.59	30.17	14.77
180 - 199	46.02	49.32	51.22	29.69	31.73	33.33	37.04	67.24	47.49	26.14
≥ 200 bpm	2.65	2.74	10.57	6.25	10.58	7.02	5.19	-	5.59	7.95

E - Experimental group

C - Control group

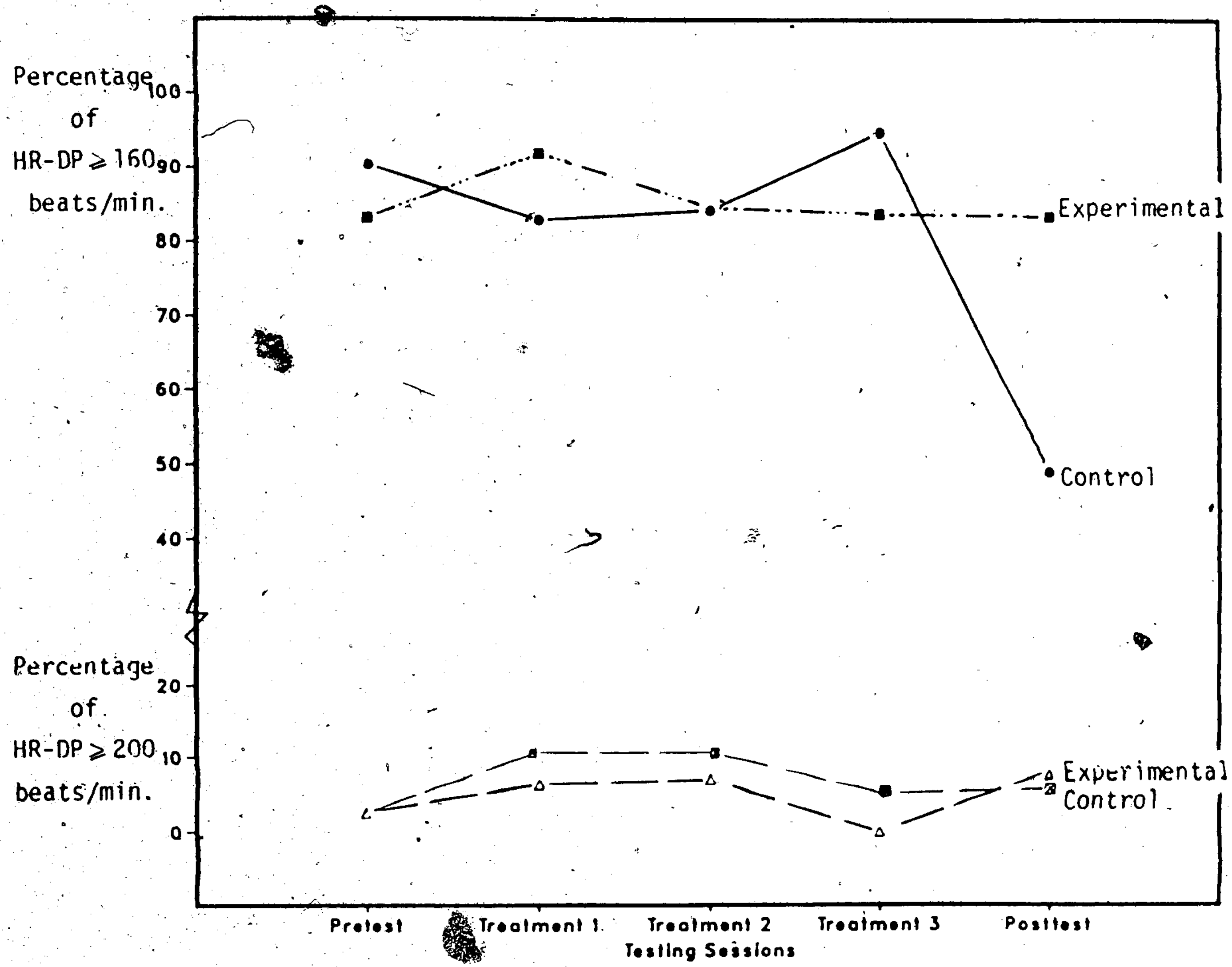


Figure 1

Percentage of heart rate data points $\geq$ 160 bpm and $\geq$ 200 bpm

(10-12 year old group)

data also showed that for experimental and control subjects, about 2.6% of the HR-DP were greater than 200 bpm, ie. at extremely severe intensity levels. For the control group, the response pattern of HR-DP ⩾ 160 bpm appeared to be slightly more variable across the five testing sessions compared to the more consistent pattern of the experimental group as shown in Fig. 1. With the exception of a very slight increase in percentage of HR-DP ⩾ 160 bpm at T1, there appeared to be very little significant changes in the HR-DP response pattern of the experimental group even when pacer-prompters were used. This provides support for Hypothesis #5. HR-DP for the extremely severe intensity level, ie. HR ⩾ 200 bpm, did increase to about 10.6% for T1 and T2 and to about 5.19% for T3 (Fig. 1). Pacing apparently caused some experimental subjects to work at even higher intensity levels and for longer durations.

Percentages of HR-DP ⩾ 160 bpm for the control group at posttest represents a decrease of 45.96% from T3. It should be noted that 43.18% of the HR-DP for the control group at posttest falls within the HR interval of 120-159 bpm. On average, in all other testing sessions, only 2.74% - 12.51% of HR-DP falls within this same HR interval for both experimental and control groups.

An interesting "reverse" phenomenon in HR-DP percentages for HR ⩾ 160 bpm was observed during T1 and T3 (Fig. 1). During T1, experimental subjects registered approximately 91.87% of HR-DP ⩾ 160 bpm, compared to 82.82% obtained for the control group, a difference of 9.05%. Almost the reverse happened during T3. Control subjects spent 94.83% of the HR-DP at ⩾ 160 bpm, compared to 83.71% spent at that intensity by experimental subjects. It should be remembered that most of the experimental subjects achieved Best-T-times during T1.

13-and-older Group

Interesting differences in HR-DP percentages and response patterns between experimental and control subjects, and between this group and the 10-12 year olds, were observed when the HR data for this group were analyzed. Table 11 shows the percentages of HR-DP in each of the seven HR intervals. Figure 2 shows the percentages of HR-DP for HR $\geqslant$ 160 bpm and HR $\geqslant$ 200 bpm for both experimental and control groups.

HR-DP percentages for HR $\geqslant$ 160 bpm, for all five testing sessions, fall between 65.01% to 79.63% for the experimental group and between 55.13% to 77.92% for the control group. The percentage of HR-DP $\geqslant$ 160 bpm for the 13-and-older subjects was therefore less than that obtained for the 10-12 year old subjects. During the three T sessions, experimental subjects seemed to be spending a greater percentage of time performing at HR $\geqslant$ 160 bpm than the control group (Fig.2). Experimental subjects registered a mean of 75.88% at HR $\geqslant$ 160 bpm compared to the control group's mean of 55.94%, a difference of approximately 20.0%. The experimental group was therefore performing at the vigorous-severe intensity level for longer durations than the control group. That the control group was therefore spending more time in another HR interval other then HR $\geqslant$ 160 bpm during the T sessions is evident when one examines the other HR intervals. The control group spent almost twice the amount of time, when compared to the experimental group, at HR interval 120-159 bpm. Control subjects spent about 42.43% of HR-DP at 120-159 bpm while experimental subjects spent approximately 21.42% at that same HR interval.

If the 10-12 year old control subjects' HR-DP percentages at posttest are not considered, the 13-and-older subjects' HR-DP percentages within the interval of 120-159 bpm would be much greater than their younger

Table 11

Percentage of heart rate data points in the 7 HR intervals

(13-and-older group)

HR INTERVAL	PRETEST		T1		T2		T3		POSTTEST	
	E	C	E	C	E	C	E	C	E	C
≤ 100 bpm	1.88	2.50	1.07	-	1.38	-	1.04	-	1.23	1.30
101 - 119	0.63	1.25	2.14	1.87	0.92	0.99	1.56	2.08	2.06	-
120 - 139	4.38	-	2.14	9.35	1.83	3.96	0.52	3.13	3.29	-
140 - 159	28.13	25.0	20.86	33.64	16.51	37.62	22,40	39.58	20.16	20.78
160 - 179	30.63	38.75	40.64	35.51	55.96	31.68	44.79	46.88	55.56	46.75
180 - 199	33.13	32.50	32.09	18.69	22.94	24.75	29.69	8.33	17.70	31.17
≥ 200 bpm	1.25	-	1.07	0.93	0.46	0.99	-	-	-	-

E - Experimental group

C - Control group

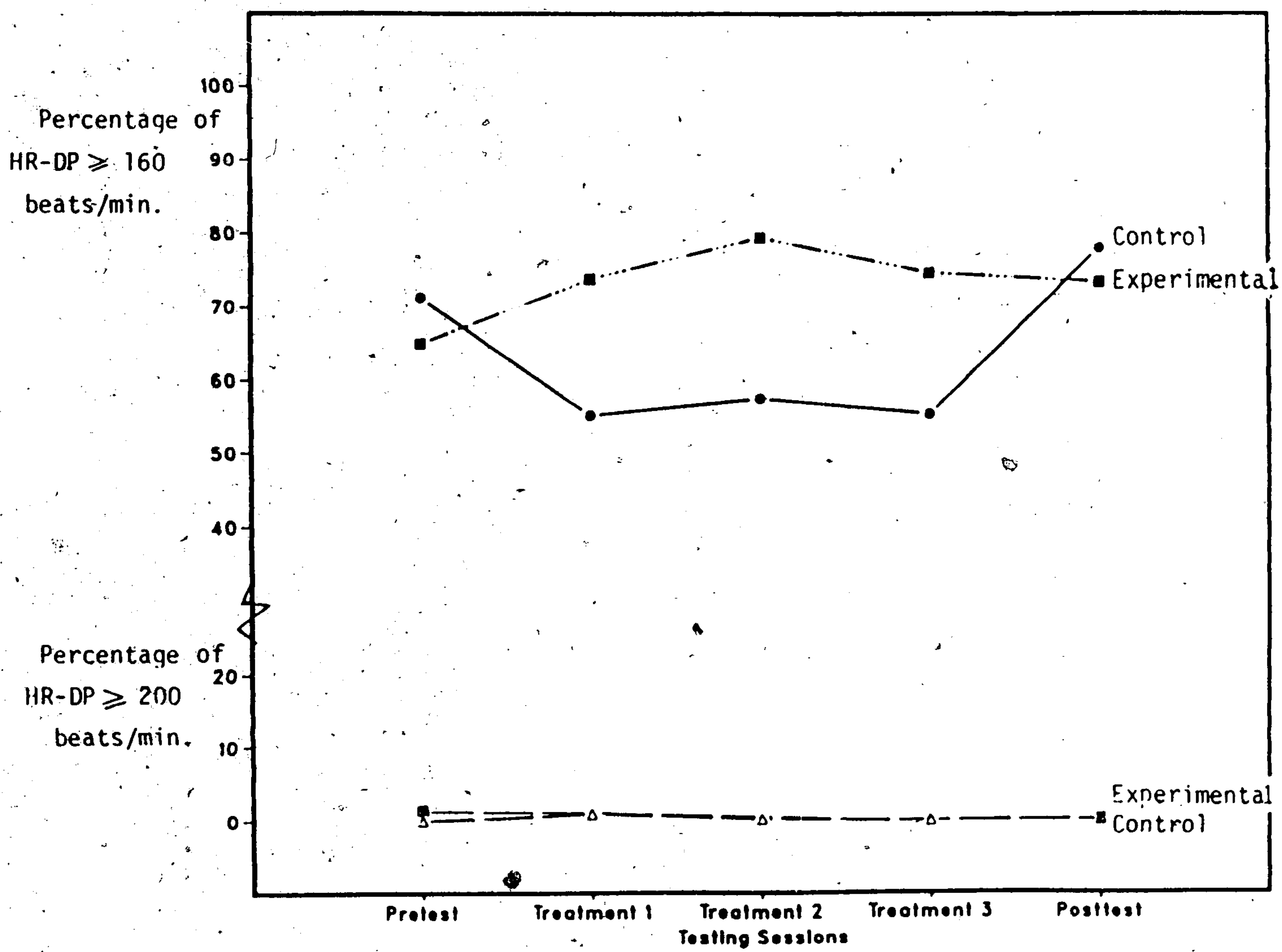


Figure 2

Percentage of heart rate data points ≥ 160 bpm and ≥ 200 bpm

(13-and-older group)

counterparts across all testing sessions. Older subjects were therefore spending more time at the moderate intensity level than the 10-12 year olds.

The older subjects generally also spent minimal, or almost negligible, time performing at the extremely severe intensity where HR $\geqslant$ 200 bpm (Fig. 2). Forty-six of a hundredth percent to 1.07% of the experimental subjects' HR-DP were greater than 200 bpm; 0.93% to 0.99% of the control subjects' HR-DP were greater then 200 bpm during T1 and T2. These percentages are much lower than those obtained for the younger group.

Heart-rate DP pattern for HR $\geqslant$ 160 bpm appears to be quite consistent for the experimental group from T1 to posttest (Fig.2). Consistency in the response pattern is also noted for the control group from T1 to T3. A certain amount of variability is noted in the response pattern of the control subjects when pre and post results are compared to T session results.

MAXIMAL HEART RATE

10-12 Year old Group

The maximal HR values obtained by each subject during each testing session appeared to be rather high. Table 12 shows the maximal HR values at pre and posttest, and also the mean maximal HR for the T sessions.

The mean maximal HR for the experimental group over the five testing sessions is 196.6 bpm; the mean maximal HR for the control group is 192.6 bpm. Mean maximal HR values for individual experimental subjects range from 184.5 bpm to 210.4 bpm. Mean maximal HR for individual control subjects range from 173.0 bpm to 200 bpm. Mean HR $\geqslant$ 200 bpm was recorded by five experimental subjects during T sessions. The changes in maximal HR values from pretest to T sessions to posttest do not seem to follow a general trend in either experimental or control group. Individual mean maximal HR values appear to be only slightly below the predicted maximal HR (Predicted max. HR = 220 - Age).

13-and-older Group

Maximal HR values attained by 13-and older subjects were slightly lower than values obtained by the younger subjects. Table 13 shows that the mean maximal HR for the experimental group was 186.3 bpm while the mean for the control group was 187.2 bpm. Mean maximal HR ranging from 175.0 bpm to 199.6 bpm was recorded by experimental subjects while values for control subjects range from 178.6 bpm to 198.2 bpm. Five experimental subjects showed an increase in their maximal HR from pretest to T sessions. Increases in maximal HR ranged from 3.76 bpm for one subject to 9.0 bpm - 11.7 bpm for the other four experimental subjects.

On the average, maximal HR of experimental subjects seems to increase during T sessions when compared to pretest values. Posttest values are also lower than T values for the experimental subjects. Such a trend was not exhibited by the control group.

INDIVIDUAL DIFFERENCES IN PERFORMANCE AND HEART-RATE RESPONSE

Large variability in performance time and HR response pattern on the run was observed in subjects tested. The large inter-individual differences observed among subjects point out clearly that the selected sample was not homogenous in nature. The observed inter-individual differences could be indicative of individual differences in motivation level, cognitive understanding of pacing and pacing abilities, cardiovascular fitness level, tolerance level for physical discomfort and

Table 12

Maximal heart-rates (bpm) of 10-12 year old subjects

SUBJECTS	PRETEST	MEAN-T-MAX.	POSTTEST	OVERALL MEAN
<u>EXPERIMENTAL</u>				
SE1	201.0	202.5	203.0	202.3
SE2	-	201.5	200.0	201.0
SE3	204.0	211.5	207.0	208.5
SE4	178.0	185.0	191.0	184.7
SE5	185.0	187.3	175.0	184.4
SE6	190.0	-	189.0	189.5
SE7	243.0	201.7	204.0	210.4
SE8	-	200.3	190.0	197.8
SE9	-	184.7	186.0	185.0
OVERALL GROUP MEAN ON ALL FIVE SESSIONS				196.6
<u>CONTROL</u>				
SC1	199.0	200.0	201.0	200.0
SC2	202.0	199.0	189.0	197.6
SC3	180.0	175.0	189.0	197.6
SC4	194.0	189.0	207.0	193.6
OVERALL GROUP MEAN ON ALL FIVE SESSIONS				192.6

- : No heart-rate data available

Table 13

Maximal heart-rates (bpm) of 13-and-older subjects

SUBJECTS	PRETEST	MEAN-T-MAX.	POSTTEST	OVERALL MEAN
EXPERIMENTAL				
SE10	168.0	177.0	176.0	175.0
SE11	192.0	200.0	191.0	195.8
SE12	209.0	196.7	199.0	199.6
SE13	172.0	183.7	179.0	180.4
SE14	175.0	184.0	183.0	181.5
SE15	–	188.0	186.0	187.5
SE16	183.0	186.7	185.0	185.6
OVERALL GROUP MEAN FOR ALL FIVE SESSIONS				186.3
CONTROL				
SC5	198.0	198.7	197.0	198.2
SC6	185.0	184.0	–	184.3
SC7	175.0	179.0	181.0	197.6
OVERALL GROUP MEAN FOR ALL FIVE SESSIONS				187.2

– : No heart-rate data available

pain, as well as running efficiencies. Intra-individual variability across testing sessions also indicated that the above mentioned variables do not always remain consistent for any individual across sessions. The following examples are selected descriptions of performance capacities and HR response patterns to the endurance run. Heart-rate response patterns of all other subjects not described here are included in Appendix G.

Experimental Subject SE1

Subject SE1, a female, was the fastest of all the experimental subjects in this age group. Her best time for the 1,200m run, 5:59 min., was achieved during T3. The 'Excellent' award level was achieved on all testing sessions that the subject participated in. Of the two T session testings that subject SE1 was present for, only the T3 performance was better than pretest. Posttest performance was the worst of all the four runs. Subject SE1 was absent for T2.

Figure 3 shows the HR data points recorded by subject SE1 for every 30-second interval for each of the testing sessions. 89.1% of the total HR-DP was $\geqslant$ 173 bpm; 13.60% of total HR-DP was $\geqslant$ 200 bpm. During T3, 38.46% of HR-DP recorded for that session was greater than or equal to 200 bpm and occurred from the 4th min to the 6th min where the run was then completed. A maximal HR value of 210 bpm was recorded by subject SE1 at T3.

Experimental Subject SE5

Subject SE5 was an 11.2 year old male. Of all the experimental subjects, he showed the greatest variability in performance from session to session. In five testing sessions, this subject changed three different award levels (See Table 7). Best time for the run was achieved during T1. Times completed for T2 and T3 were worse than pretest.

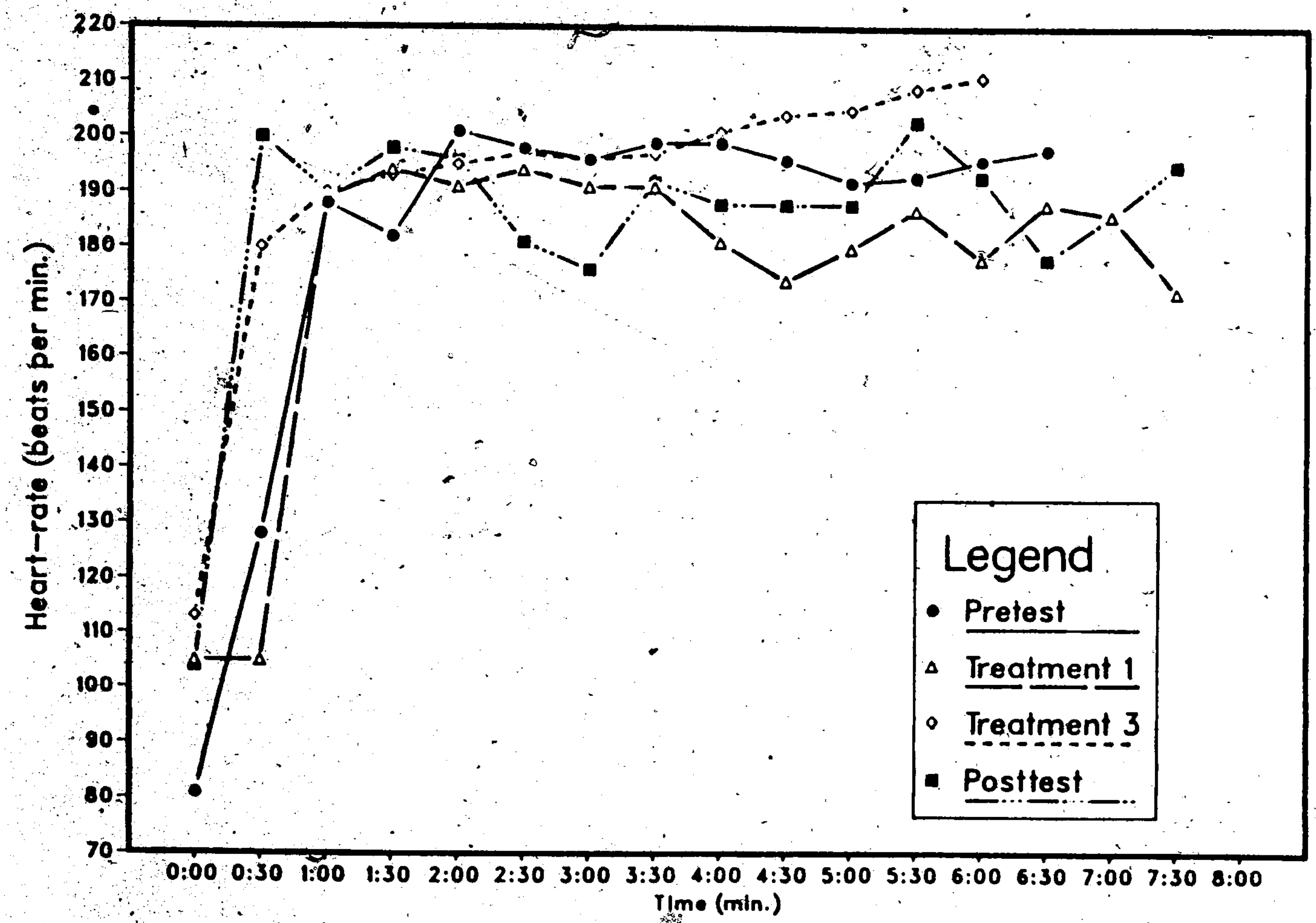


Figure 3

Heart rate data points of Subject SE1

Subject SE5's heart-rate response over every 30-second interval during the run is represented in Figure 4. Twenty-nine percent of the total HR-DP was > 170 bpm; 40.0% was > 160 bpm but < 170 bpm; and 31.0 % was < 160 bpm. Of the five testing sessions, HR response pattern was most variable during T2 and posttest. Interestingly, the times taken during these two sessions were the slowest of the five runs (See Table 6). Only 9.5% and 4.5% of HR-DP recorded for T2 and posttest respectively was ≥ 170 bpm. A maximal HR value of 218 bpm was recorded for Subject SE5 during T1.

Experimental Subject SE7

Subject SE7 was a 12.5 year old female. Her best time for the 1,200m run was achieved during T1. All T sessions' performances were better than pre and posttest. Pretest performance was the slowest. The highest award level achieved by this subject was the 'Bronze' level.

Figure 5 depicts the HR-DP of Subject SE7 for the five testing sessions. Heart-rate response pattern for Subject SE7 appeared to be fairly consistent with little variability. Of the total HR-DP, 85.8% was ≥ 180 bpm; 6.2% of total HR-DP was ≥ 200 bpm. It should be noted that except for HR-DP recorded for T3, about 87.0% to 90.9% of HR-DP recorded for individual sessions was ≥ 180 bpm. Compared to Subject SE5, Subject SE7 was physiologically working at a much higher intensity level and for longer durations. Yet, this subject was much slower than Subject SE5.

The maximal HR value recorded for this subject was 243 bpm at pretest. However, it is believed that this value was the result of some interference caused when Subject SE7 and another subject decided to hold hands and run together mid way through the second to third minute of the run. They were immediately separated by the testers but it was highly possible that Subject SE5's microcomputer picked up the signal from the

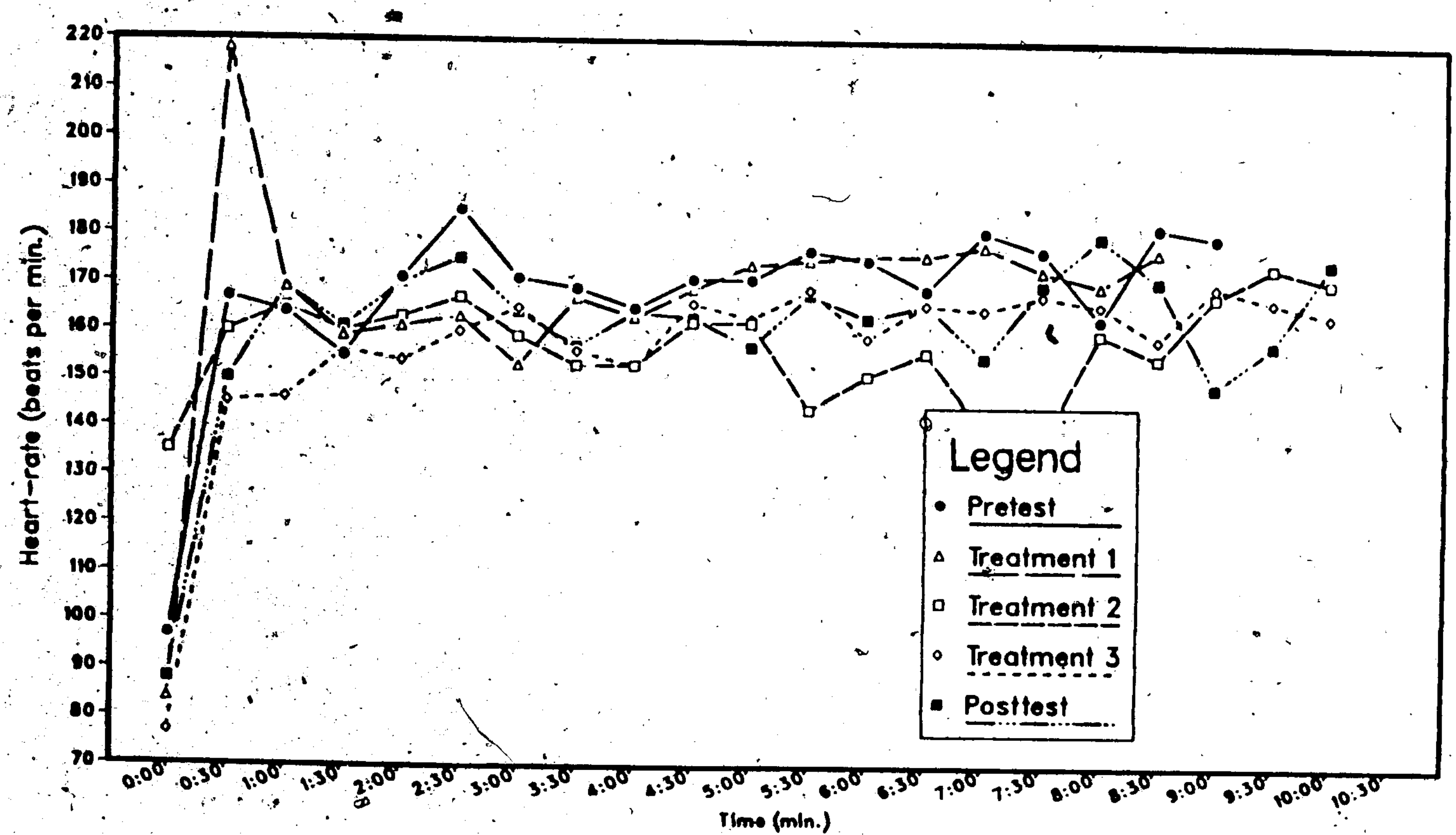


Figure 4

Heart rate data points of Subject SE5

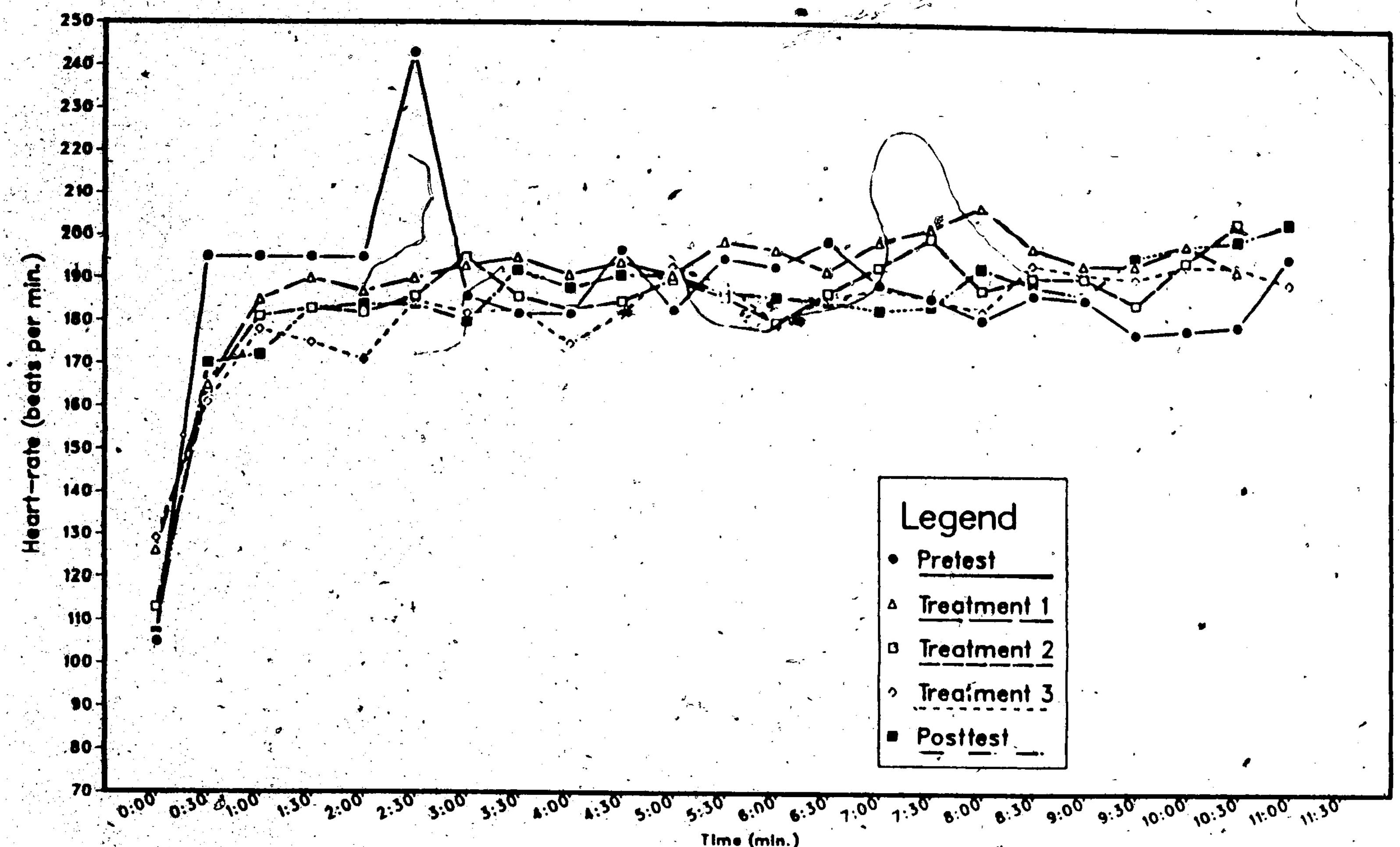


Figure 5

Heart rate data points of Subject SE7

other subject's transmitter beside its own. The consistency of the other HR-DP recorded for this subject suggests that it was highly improbable for Subject SE7 to have achieved such a high HR value.

Control Subject SC1

Subject SC1, a 12.1 year old male, was the fastest runner of all the 10-12 year old subjects. The 'Excellent' award level was achieved on every testing session. Best time of 5:39 min was achieved during T1 and T2. All T sessions' performances were better than pre and posttest, but the differences in time were very slight (See Table 7). It was apparent that ceiling effects were being observed in this subject's performance.

Heart-rate responses recorded during the runs provided some support to suggest that this ceiling effect was in fact taking place (Figure 6). For almost all testing sessions, after the first minute, Subject SC1's HR response pattern was highly consistent. Except for HR-DP recorded during T2, almost all other HR-DP, after the first minute, were between 190 - 200 bpm. 67.3% of total HR-DP were between 190 -199 bpm; 9.62% of total HR-DP was $\geqslant$ 200 bpm. Of the HR-DP recorded for T2 alone, 30.77% was $\geqslant$ 200 bpm. During T2, Subject SC1 maintained a steady-state HR of 157 bpm for about 2 min.; after which his HR drastically increased to 194 bpm and subsequently stayed at about 200 bpm or higher till the completion of the run. Obviously, Subject SC1 was physiologically working at highly vigorous to severe exercise intensities throughout all the testing sessions.

Control Subject SC2

Subject SC2, an 11.9 year old male, achieved a best time of 8:08 min during pretest and a worst time of 10:53 min during posttest. This subject showed the greatest intra-individual variability in performance among all

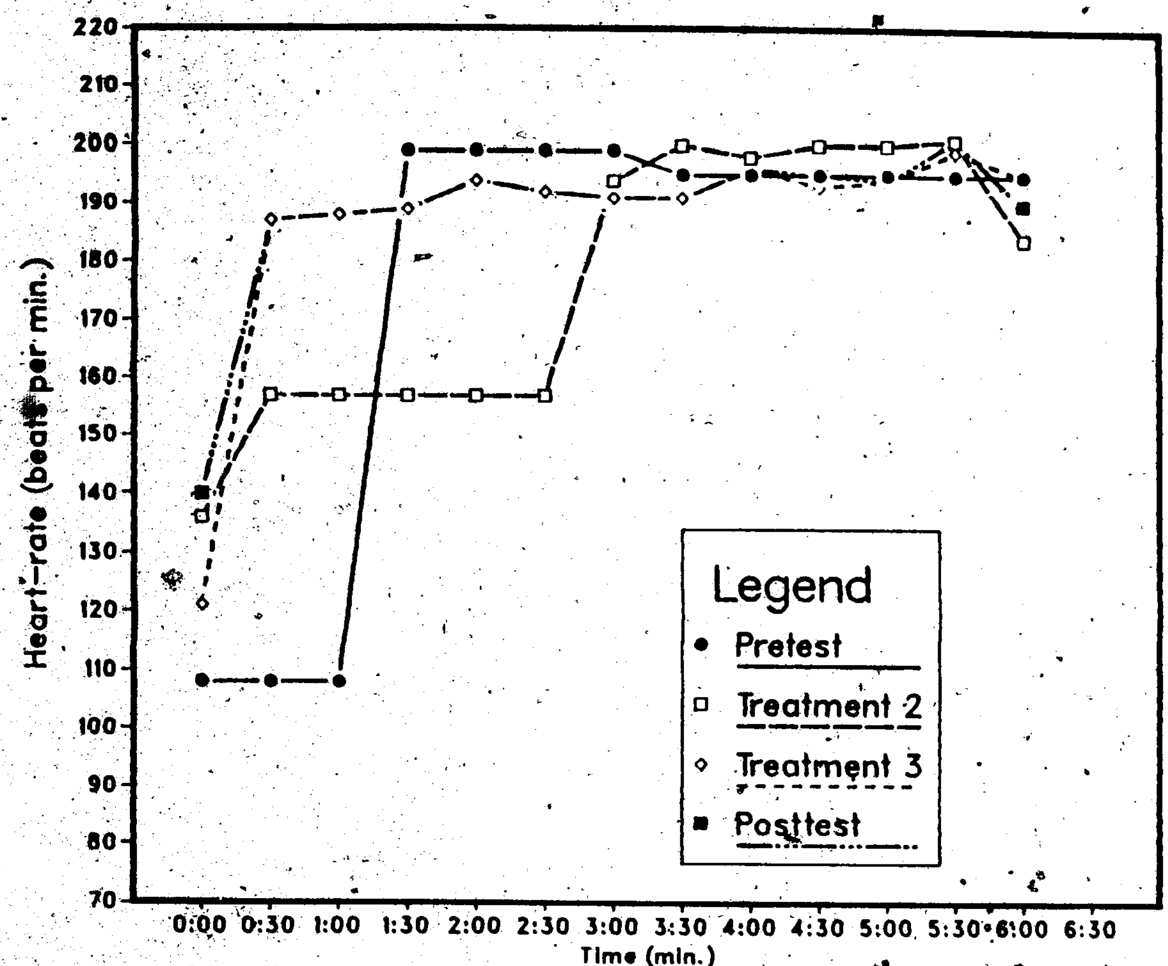


Figure 6

Heart rate data points of Subject SC1

the younger subjects - he changed four different award levels within five testing sessions (See Table 7).

The variability of subject SC2's performance is also clearly demonstrated by his HR response pattern. Fig. 7 graphically depicts the tremendous variability in HR response pattern. That subject SC2 had a very inconsistent and uneven pace is indicated by the sharp rise and fall of HR-DP during the run. HR-DP pattern of posttest provides the most dramatic example of this subject's variable running pattern. Subject SC2 was a very difficult subject to motivate or instruct; he sprinted, walked, stopped and jogged whenever he felt like it. Despite the high percentage of posttest HR-DP in the mild to moderate intensity level, 73.9% of HR-DP was $\geq$ 160 bpm, this subject posted a better posttest time than subject SE7. Maximal HR recorded by subject SC2 was 205 bpm.

Experimental Subject SE12

Subject SE12 was a 16.2 year old male who demonstrated the greatest performance improvement of all the older subjects. He was ranked fourth among all 13-and-older subjects based on pretest time; however, he became the fastest runner of the group during T3 when he completed t[illegible]0m in 11:22 min. The pacing protocol appeared to be most successful with this subject - his performance time improved sequentially on all treatment sessions (See Table 8). From a 'No award' level at pretest, subject SE12 was able to achieve the 'Gold' award by T3 (See Table 9).

Subject SE12's HR response to the run is graphically represented in Fig. 8. Of the total HR-DP recorded, 46.43% was between 140 to 159 bpm, while 49.28% was $\geq$ 160 bpm. During T3, 87.5% of the HR-DP recorded for that session was $\geq$ 160 bpm. Except for pretest, HR response pattern for all other sessions appeared to be fairly consistent with very slight

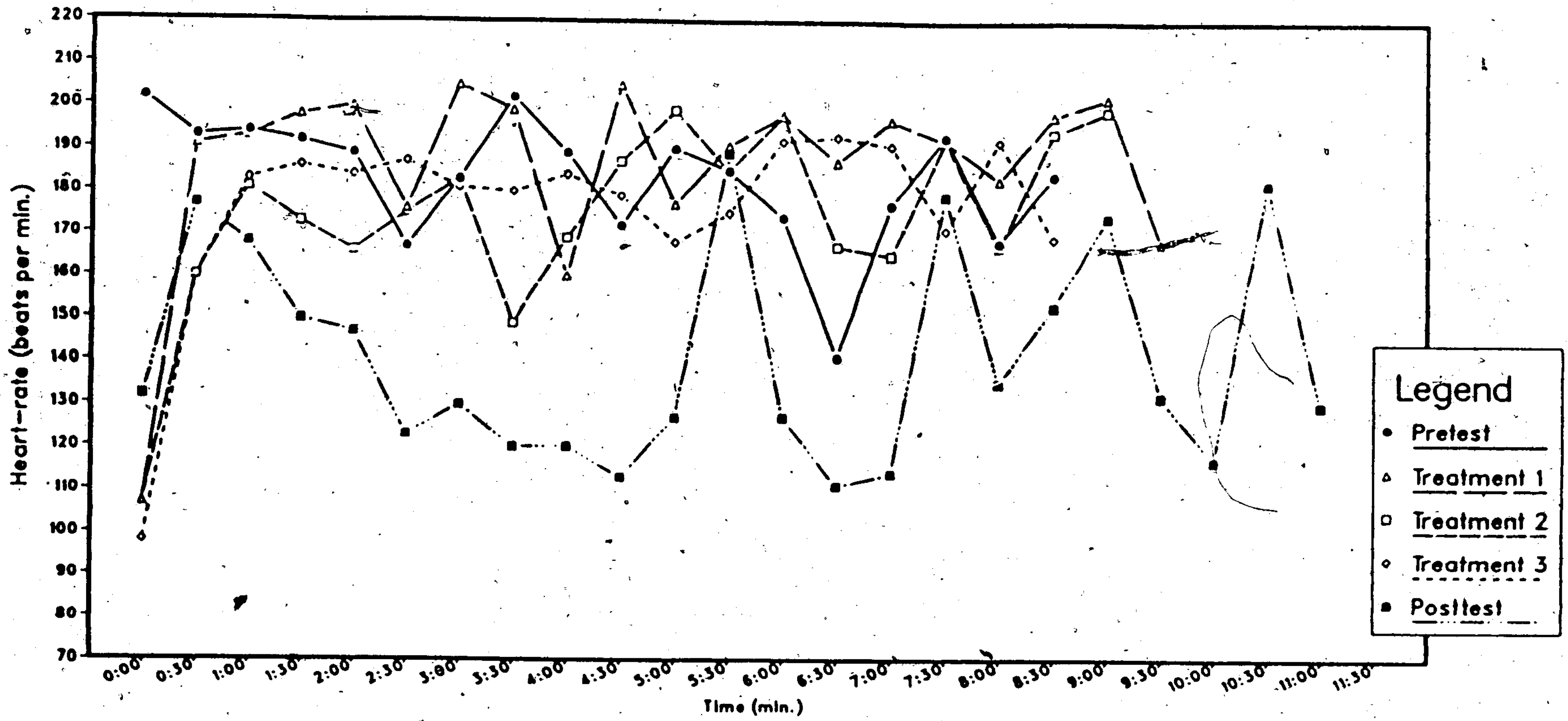


Figure 7

Heart arte data points of Subject SC2

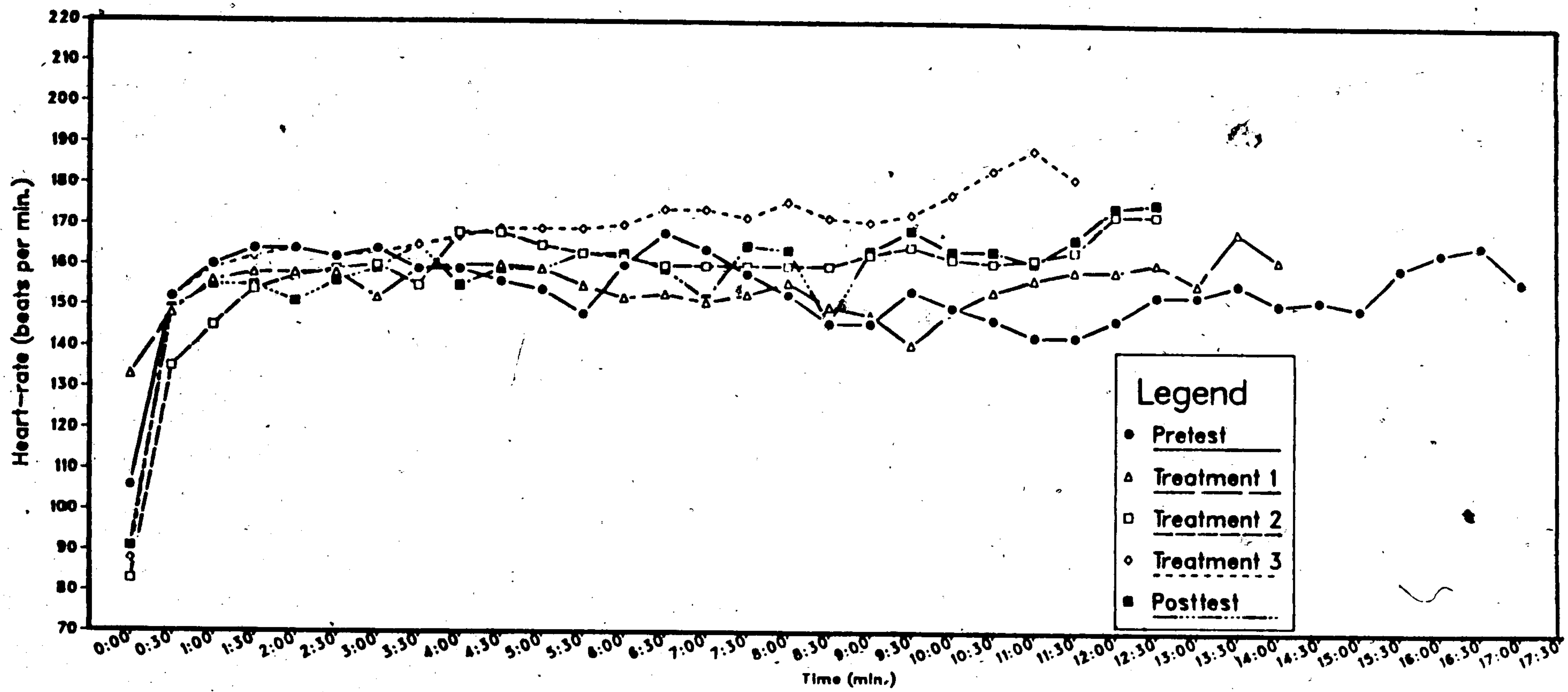


Figure 8

Heart rate data points of Subject SE12

variability. The maximal HR recorded by subject SE12 was 199 bpm.

Experimental Subject SE15

Subject SE15 was a 17.4 year old male. He was unable to complete the run during pretest, T1 and T2. This subject showed tremendous improvement during T3 by completing the 2,000m in 15:03 min. He kept up very well with the pacer-prompter during T3 and was wanting to go faster than the pacer. The pacer was thus instructed to quicken the pace slightly to see if the subject was still able to keep up. Subject SE15 did. His time of 15:03 min was definitely much faster than the 17:30 min pace that was originally determined for him based on T2 performance. Subject SE15 completed the posttest independently with a time of 15:46 min. No award levels were achieved on any testing session.

An examination of this subject's heart-rate response patterns (Fig. 9) indicates that Subject SE15's inability to complete the run during earlier testing sessions could hardly be attributed to a lack of motivation. During T1 and T2, 66.66% and 96.55% of the HR-DP was $\geqslant$ 160 bpm respectively. Of these percentages, 36.36% and 41.38% were $\geqslant$ 180 bpm. HR-DP recorded for T3 showed Subject SE15 was working extremely hard and at very severe intensities. 83.87% of the HR-DP for that particular session was $\geqslant$ 180 bpm. A maximal HR value of 192.0 bpm was recorded by Subject SE15 during T3.

Control Subject SC6

Subject SC6 , a 17.1 year old male, showed variable performance across testing sessions (See Table 8). His best time for the 2,000m, 16:15 min., was achieved at T2. He refused to complete the run at T3 and was absent during posttest. No award levels were achieved by this subject.

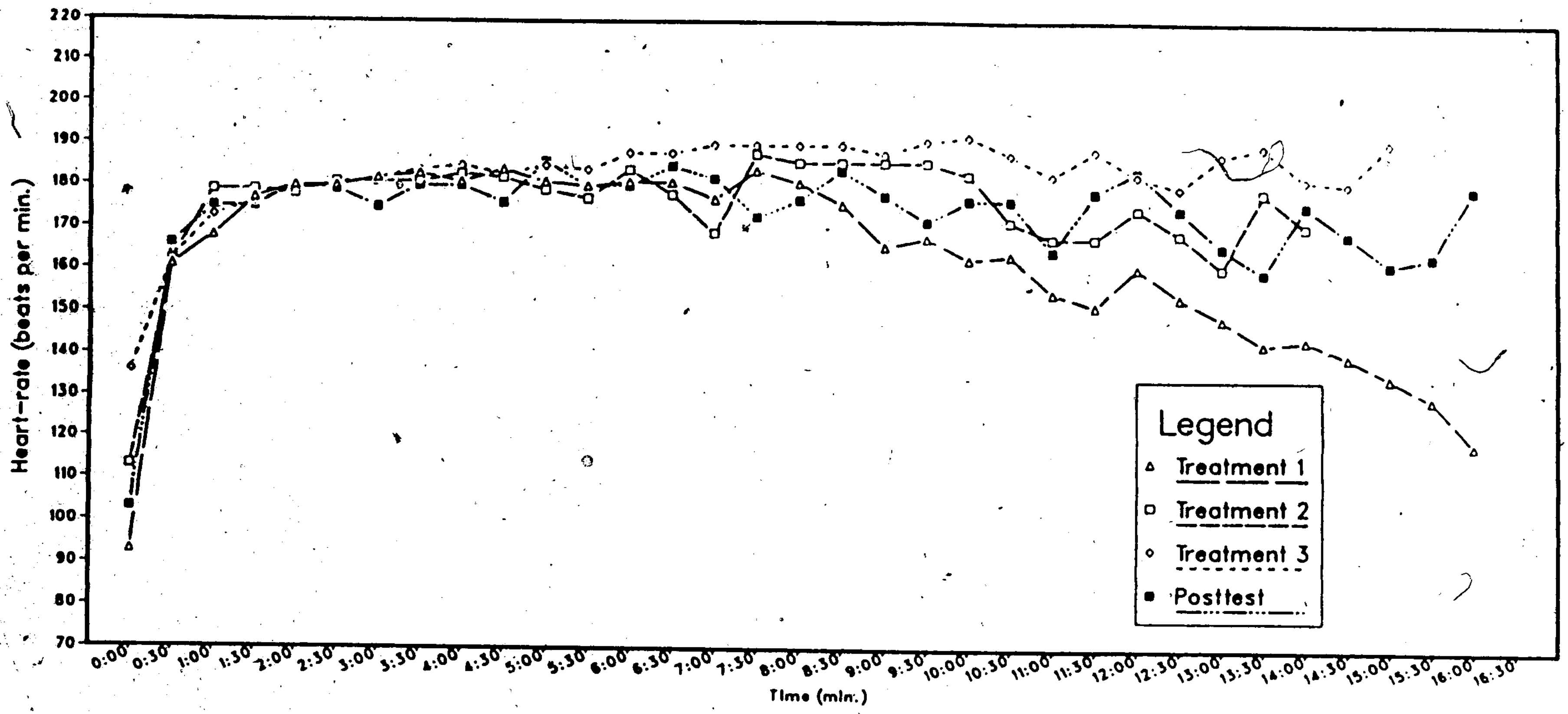


Figure 9

Heart rate data points of Subject SE15

Figure 10 is a graphical representation of Subject SC6's heart-rate response to the run. Response patterns indicate that this subject's HR-DP were quite variable, both within and across testing sessions; he also worked at moderate to vigorous exercise intensities during the run. Of the total HR-DP recorded, 38.35% was in the 140-159 bpm interval while 44.36% was found between 160-179 bpm. Only 9.02% of total HR-DP was $\geq$ 180 bpm. The highest HR value reached by this subject was 187.0 bpm.

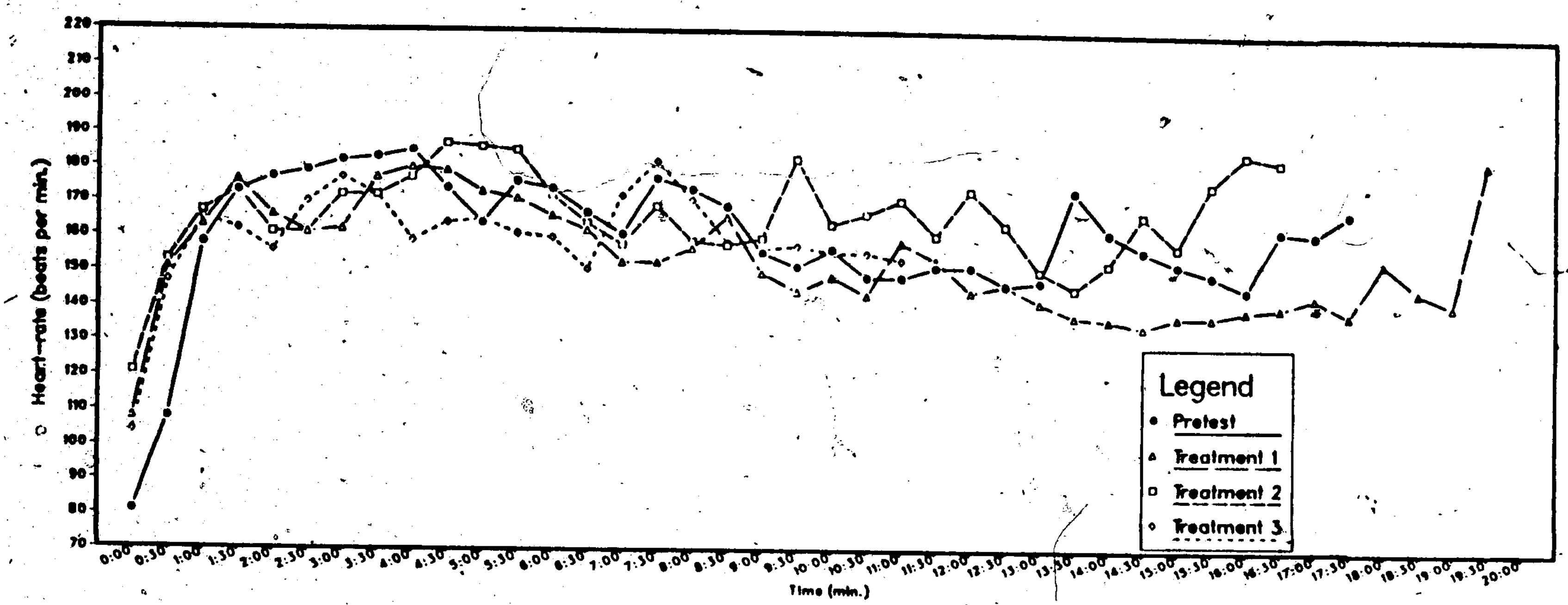


Figure 10

Heart rate data points of Subject SC6

CHAPTER FIVE

DISCUSSION

Attempts to evaluate the CV fitness of the TMH in laboratory settings have been few and far between. Not many researchers have tried or are interested in carrying out such testings. Understandably, it is very difficult to test the MH, especially the TMH, on a treadmill or bicycle ergometer (Nordgren, 1970; Cummings et al., 1971). Trainable mentally handicapped subjects often have difficulty understanding the task and its requirements (Reid et al., 1985). Even if TMH subjects do understand the test, there are always the problems of motivation and risks involved in such testings, especially in maximal performance tests. The endurance run is therefore an ideal alternative test of CV fitness that can be used with the TMH because running is not a totally strange or new skill. The ease of administration and simplicity of facility, equipment and expertise needed for administering the run make it evident why estimation of TMH's CV functions is usually assessed by an endurance run.

Ideally, the CFA-Adapted endurance run is a suitable and useful test for evaluating the CV fitness of TMH children and youth because of the assumed simplicity of the skill involved. Unfortunately, extremely few TMH participants tested across Canada were able to complete the run. Although it is accepted that the CV fitness of the TMH is generally low, there are doubts that it is this low CV fitness that is totally accountable for the extremely poor performance reported. It is speculated that the reported failures of test completion are also partly due to low motivation, absence of an appropriate pacing strategy and/or the lack of understanding of the test requirements.

The importance of an appropriate and optimal pace during endurance running is often mentioned and acknowledged, but sadly overlooked by those involved in such testing. Too often, mention is made of the need to establish proper pacing during a running test (Morehouse & Miller, 1971; McArdle et al., 1981; Dorociak & Nelson, 1983) but little attention has been paid to determining how a pacing strategy can be incorporated into such a test. Not many researchers and testers realize that proper pacing and practice have a tremendous influence on the reliability and validity of an endurance run test, especially when inexperienced and/or MH subjects are tested. The proper pace for running a distance event is crucial for optimal performance (Dorociak & Nelson, 1983). Unfortunately, in a typical endurance performance setting, subjects are often left to 'self-select' the pace by trial and error, or more often, by their motivational levels and willingness to endure the discomfort and pain of fatigue. Although the endurance run is considered a submaximal field test of CV endurance, the very nature of the run itself tends to make it more of a maximal performance test. Subjects are often told to "run as fast as possible", "go all out!", or "give it your best effort" (Cooper, 1972). As a result, inexperienced subjects too often begin the run with an injudicious pace, sprinting the initial 100m to 200m. Such a pace often forces subjects to slow down, or even walk, due to the buildup of lactic acid as the run progresses (Katch et al., 1973; McArdle et al., 1981). Such a pattern of performance is often seen when testing inexperienced and/or MH subjects. Alternatively, some subjects may begin the run too slowly and continue that way. The final performance scores obtained in such distance running thus often reflect inappropriate pacing and/or low motivational levels rather than physiological and metabolic capacity (Katch et al., 1973; McArdle et al., 1981)

Trainable mentally handicapped subjects participating in the CFA-Adapted endurance run do not have any pacing strategy provided within the current testing protocol to facilitate better performance. Participants are left to self-select a pace and run in a manner that they themselves decide upon. Since it is documented that the performance of MH persons can be affected by poor understanding of task requirements and/or insufficient motivation, it is therefore not too surprising that TMH performance on the CFA-Adapted endurance run is far from satisfactory. Granted that the CV endurance of the TMH is generally poor, it is still doubtful that most TMH participants in the endurance run ever achieve an appropriate pace, let alone an optimal pace. Unfortunately, it is also highly possible that the TMH do not have a clear understanding of the concept of pacing. If performance on the endurance run is to be considered a valid estimate of CV endurance, then confounding variables like motivation and pacing must be reduced to a minimum. The most sensible procedure to achieve this is to incorporate a systematic pacing strategy into the CFA-Adapted endurance run test protocol itself. A systematic pacing protocol, used in conjunction with pacer-prompters, was therefore designed and introduced into the CFA-Adapted endurance run test. Two different age groups of TMH subjects were then tested with the proposed protocol to determine the effect of the proposed pacing strategy upon performance.

Although there is no documented evidence, it was observed that during the pre- and the posttest, subjects tended to sprint the initial 100m to 150m, and then slow down and finally sprint again when told that they have about 100m left to complete the run. Some subjects even stopped or walked during the test. During the T sessions, experimental subjects were running more consistently and at a more even pace because they were concentrating on keeping up with the pacer-prompters. Also, because they were told not to run faster than the pacer-prompters from the start, there were fewer sudden spurts of sprinting and stopping. Stopping and walking during the run by experimental subjects were reduced considerably when compared to control subjects' pattern of running.

From the start of the study, it was speculated that the introduction of a systematic procedure for determining individual running paces, and the use of pacer-prompters, should be able to increase the number of subjects who can complete the CFA-Adapted run. This possibility was hypothesized because of two major factors:

1) The pace determined for each subject during the T sessions was <u>individualized</u>; that is, it was systematically based on the subject's pretest performance. In all three T testings subsequent to the pretest, each experimental subject was challenged in a manner appropriate to his/her initial performance. Basing pace times on individual pretest performances, and then systematically upon subsequent runs, was crucial because if a subject's initial performance was not considered, there was the danger that the subject would be randomly paced, possibly resulting in the subject being over- or under-exerted. Pretest results demonstrated that there were indeed larger inter-individual differences in performance between subjects. The possibility of using an inappropriate pace was clearly demonstrated in a pacing study reported by Katch and co-workers (1973). Katch et al. reported that none of their non-MH subjects were able to maintain a required pace for the full 10-minute duration of a running test. Subjects were paced by means of a bicycle. The major limitation of this study was that the pace

determined for all the subjects was not based on any pretest performance. An arbitrary pace of 10 mph (6 min. per mile) was used for all subjects, regardless of individual capacities. Apparently, the pace set was too fast.

2) The availability of pacer-prompters would reduce the need for TMH subjects to plan how to run the required distance. An appropriate pace was established for each subject by the pacer-prompters. In the event that TMH subjects did not understand that they should have an even pace; or that there was such a concept as "pacing", the use of pacer-prompters helped to keep the subjects motivated to run after a specific object. Running after a pacer-prompter also helped to break the monotony of running endlessly, and often times, meaninglessly, around the track. Hopefully, motivation levels would be maintained higher than when subjects have to run on their own.

When the proposed pacing protocol was used with experimental subjects in this study, the completion rate of the run increased by 22.22% for 10-12 year olds, and 42.85% for the older subjects. No increase in completion rate was noted for the control subjects. If the effectiveness of the proposed protocol is determined by the changes in percentage completion of the run from pretest to T sessions, then it can be concluded that the proposed protocol was effective. This lends support to Hypothesis #1.

Completion of the run across all five testing sessions was much higher for the 10-12 year olds than the older subjects. This tendency is also noted in the results obtained from nation-wide testings of 3,172 TMH participants. Apparently it was easier for the 10-12 year olds to complete the run. It could be that the 10-12 year olds were simply much fitter aerobically. Alternatively, and more plausibly, this could be because the running distance for the 13-and-older youth was much longer. Thirteen and older subjects have to run 800m more. It seems reasonable to argue that a longer distance made it harder for the subjects to stay motivated, to plan and keep a reasonable pace. Even the use of a systematic pacing protocol was unable to immediately change the subjects' difficulty in completing the run. Interestingly, the percentage of completion increased gradually from T1 to T3 and then dropped at posttest. The highest completion rate was achieved at T3. This observation was not evident in the 10-12 year old group. This seems to suggest that to complete longer distances, more pacing sessions are needed by TMH subjects to allow them to learn to keep up with the pacer-prompters. It is reasonable to believe that it was a learning effect, and not training, that enabled the 13-and-older subjects to complete the run. It was highly improbable that there were any physiological training effects, considering that subjects merely ran about 12 to 18 minutes once a week during the testing. The teachers confirmed that no running exercises were conducted in the school either. It would definitely require more, and longer running practices for any training effects to be evident (Astrand & Rodahl, 1977).

In general, better individual performances from most experimental subjects were elicited during T sessions. Significantly, it was those subjects who had poorer pretest performance who seem to be favourably affected by the pacing protocol. Improvement in time taken to complete the run during T sessions was more significant for those ranked lower in the experimental groups. Improvement by higher ranked subjects was minimal. Apparently it was those who were slower for whom pacing was more effective. Such an observation seems appropriate. The faster subjects may already be performing at near maximal potential and at high motivational levels. It was therefore very difficult for them to run any faster even if they were paced. It is possible that a ceiling effect was being observed. Heart-rate response data on faster subjects indicated that they were indeed performing at extremely severe intensity. On the other hand, those slower subjects might be performing below potential during the pretest. Factors like low motivation levels and inappropriate pacing may explain the low pretest performance. When paced during the T sessions, motivational and pacing variables were reduced to a minimum and subjects were challenged to perform to their true CV capacity. In essence, there was room and potential for better performance for slower runners.

The general trend of better performance by lower ranked subjects in both age groups is, in itself, a positive finding because the main concern regarding the use of the current test protocol was that about 80% of those TMH children and youths who participated in the CFA-Adapted program was either too slow to achieve an award or complete the run. If the proposed protocol had been able to improve the performance of these slower subjects, then it suggests that such a pacing protocol can be very effective with the 80% or more TMH participants experiencing difficulties with the current test protocol of the endurance run.

Although most experimental subjects had better performance during T sessions, there were apparently unforseen extraneous variables operating during the study that could have confounded the results. This made it difficult to attribute the improvement by experimental subjects entirely to the pacing protocol. This is especially true for the 13-and-older subjects. Unfortunately, two out of four 10-12 year old and two of the three 13-and-older control subjects also showed improvement in best performance during T sessions, making it difficult to determine what actually caused the change in performance during T sessions. However it must be mentioned that there were only four control subjects compared to nine experimental subjects in the 10-12 age group. In the older group, there were three controls compared to seven experimentals. Of the three 13-and-older controls, one subject never did complete the run at any testing session. Of the other two controls, better T time (compared to pretest) was achieved only once by each subject during T2. However, if mean time achieved during T sessions was compared to pretest, none of the controls would be considered to have improved. Four of the 13-and-older experimental subjects and seven of the 10-12 year old experimental subjects did improve on mean T time. If overall mean performance on the runs is to be taken as an indication of the effectiveness of the pacing protocol, then it can be said that the pacing protocol did have some effect upon performance.

A major weakness of the study was that control and experimental subjects were tested on the same day. Control subjects therefore saw the pacing that experimental subjects were receiving. This could possibly have affected them when they ran. Also, it has to be acknowledged that the testing environment was not very "naturalistic". There were more testers than would normally be present during a typical school testing; subjects received tremendous amounts of encouragement and coaxing from testers and teachers, perhaps much more than what they would have actually received when tested in their school. In fact, although the control subjects were running independently, there was a tremendous amount of "verbal pacing" going on throughout the testing. That is, every time a control slowed down, or walked, or sprinted, he or she was almost immediately verbally cued, corrected or encouraged by the testers or teachers. Phases like "don't go too fast", "slow down", "run just a little faster!", "don"t walk", "that's a good pace" and "keep running" might have prompted and "paced" the controls during the run. The possibility that "verbal pacing" could have improved performance was never considered. The concept of "verbal pacing" has never been proposed or hypothesized before. In addition, the novelty of running in the indoor track, and the attention focused on them when they were performing, are both plausible, competing explanations for the improved performance of the control subjects. In spite of the possible confounding, the fact that all 10-12 year old experimental subjects had the best performance during T sessions, and that 6 out of 7 13-and-older experimental subjects also achieved best performance times when paced is, in itself, a positive finding.

The removal of pacer-prompters during posttest was intended to determine if the proposed protocol was in fact effective. Hypothesis #3 speculated that posttest results would show decline in performance simply because the TMH subjects would not be able to pace themselves as well, or in the same manner, as when pacer-prompters were used. Posttest results indicated that for the majority of the subjects, whether experimental or control, posttest times tended to be worse than T session performances. Unfortunately, because controls once again also showed decline in performance during posttest, it cannot be conclusively inferred that it was simply the removal of the pacing strategy that caused this change in poorer posttest by experimental subjects. Possible explanations for the poorer posttest performance could be that subjects were receiving less encouragement and prompting by the fifth session. During the T sessions, and especially during the pretest, testers and teachers provided much verbal encouragement but enthusiasm expressed by teachers and schoolmates in particular decreased towards the end of the study. It was impossible to foresee, and therefore control for, the changes in behaviour and enthusiasm of teachers and students. Testers tried their best to provide as much encouragement as they could. Environmental stimuli (such as encouragements and cheering) or the lack of it, certainly could have caused the difference in posttest performance.

The overall poorer posttest performance of experimental subjects, however, does suggest that in order to elicit maximal performance from TMH participants, pacing must be used during testing. Teachers and testers may often make the mistake of thinking that it is sufficient to teach or provide pacing during practice sessions and then remove it during actual testing in the hope that the TMH participants will be able to generalize the pacing they were taught or provided. This study showed that if optimal performance is to be elicited to provide a more accurate indication of CV fitness, then pacing must be part of the testing protocol.

It would be erroneous to assume that there was a total absence of learning or carry-over of the pacing strategy from T sessions into posttest simply because posttest performance was worse than T sessions performance. Although posttest results indicated a decline in performance from T sessions, six experimental subjects did in fact perform better at posttest if posttest was compared to pretest. Again, most of the six subjects were ranked lower in the group. In contrast, three out of four control subjects had worse posttest than pretest times.

Another variable that seems to affect willingness to perform was related to some form of goal setting. The importance of this variable with regards to performance was admittedly underestimated. It was interesting to observe that subjects were really concerned with "how many more laps to go?". When subjects knew that they were almost at the end of the test, they seemed more willing to push themselves a little harder, appeared more motivated, and some even expressed relief that they were about to complete the run. In the event that subjects found out that they still had quite a few laps to go, especially in the older group, they tended to go more slowly and showed some degree of frustration. Knowledge of the goal that one is striving for seems to be an important factor that should be taken into consideration. TMH subjects should be told what they are working towards in terms that they understand. For example, 10-12 year olds were told "You have to run around the track 6 times". The concept of distance (eg. 1,200m) may mean nothing to the TMH. Positive verbal comments like "only three more to go", "that was number 8, good running!" were crucial in helping the subjects see the goal they were working towards. Throughout the testing sessions, subjects consistently inquired "How many more times around?". The power of goal setting and goal-motivation needs to be examined to determine their importance in eliciting maximum performance of the TMH.

Tremendous inter-individual differences in time performances within the population were noted in the subjects. In the younger group, the time taken to complete the 1,200m ranged from 5:39 min to 12:37 min. Time taken to complete the 2,000m by the older males ranged from 11:22 min to 20:07 min to 'Incomplete'. Such variability in individual capabilities to complete the endurance run reinforces the need for systematic individualized pacing times to be used with the TMH.

It was noted that most 10-12 year old experimental subjects achieved the best time during T1. Of the five testing sessions, percentage of HR-DP $\geqslant$ 160 bpm for this group was the highest during T1. These experimental subjects therefore worked the hardest physiologically during T1, as confirmed by heart rate data-points. Older experimental subjects, on the other hand, achieved the highest percentage of HR-DP during T2.

Surprisingly, percentage of HR-DP in the vigorous-severe intensity levels was much higher than expected when the current test protocol was used. TMH subjects were therefore working much harder than expected. There were very few differences between the values obtained by the proposed and current test protocol. This finding contradicted Hypothesis #4, which speculated that TMH subjects would work at low to mild exercise intensities when the current protocol was used. Like most individuals working with the MH, the general impression has often been one that most MH participants, especially the more severely handicapped, do not put much effort or interest into the task at hand. Low motivation and cognition levels have often been cited as reasons for such performances. The HR response data collected in this study, proved however, that such subjective evaluations are incorrect and scientifically unacceptable. Overall percentage of HR-DP in the vigorous to severe exercise intensities was much higher for the younger group than the older males; but the percentage of HR-DP $\geqslant$ 160 bpm for the older males was definitely greater than the value obtained in the low to mild intensity level. It is worthwhile to note that the percentage of HR-DP $\geqslant$ 160 bpm during all three T sessions was much higher for the 13-and-older experimental subjects than the control subjects. Percentage of HR-DP computed for pretest and posttest for this group was comparable. No such trend was observed in the younger group. Such an observation may indicate that the proposed protocol did indeed cause the older subjects to work harder; but for the younger subjects who were already working at high exercise intensities, pacing did not have the same effect.

The fact that a mean of 82.8% and 68.3% of HR-DP recorded by younger and older subjects was $\geqslant$ 160 bpm respectively provides some indication that the CFA-Adapted endurance run was physiologically very demanding upon the CV system of the TMH, especially the younger ones. The high percentage of HR-DP in the vigorous to severe exercise intensity levels can be attributed to an extremely low CV fitness level and poor mechanical efficiency of the running pattern. The low CV fitness levels of the subjects, coupled with the tendency to sprint at the start, can be clearly seen in the sharp increase in HR at the onset of the run for almost all subjects.

The assumption that running is a familiar and easy locomotive skill for all individuals needs to be re-examined. Running can be a difficult skill requiring upper and lower body coordination, as well as efficient use of such body parts. During the study, some subjects exhibited coordination difficulties, as well as immature, elementary running patterns. This was especially true of subjects SE14, SE16 and SC7. It must be pointed out that the mechanical efficiency of individuals differs in different skills (Astrand & Rodahl, 1977; McArdle et al., 1981), and that the energy expenditure and exercise exertion is therefore relative to the individual's CV efficiency. What may appear to be an easy skill for one person may be an extremely demanding task for another. This may lead to a major problem when testing the TMH.

Often, as was observed in this study, those subjects with inefficient, elementary running patterns do not appear to be motivated or 'working hard enough'. Subjects were therefore often judged subjectively as to how motivated or hard they are working by the behaviours exhibited, or perceived to be exhibited, during the run. The true intensity and motivational levels that TMH subjects worked at are seldom accurately determined by such subjective evaluations because teachers and testers often do not appreciate the large individual differences between subjects in movement and CV efficiencies. There is therefore the danger of testers expecting better performances, resulting in over-exertion of such children. Teachers, testers and track coaches working with TMH children are therefore advised to monitor the HR-response patterns of such children during such runs or tests, and not to depend totally on subjective evaluations when attempting to motivate their children to achieve better performances. It is true that there is tremendous room and potential for TMH children to improve CV fitness levels and running performances, but such improvements should be gradually achieved through long-term CV upgrading and skill improvement programs and not in a single testing session.

Individual and group mean maximal HR values recorded by subjects in this study were comparable to mean values previously reported for MH and non-MH children tested in maximal laboratory tests. For example, Ericksson & Saltin (1974) reported a mean maximal HR value of 196 bpm for 11.6 and 12.6 year old non-MH boys tested on electrically braked bicycle ergometers. The group mean maximal HR obtained in this present study's 10-12 year old experimental and control subjects was 196.6 bpm and 192.6 bpm respectively; 13-and-older experimental and control subjects recorded lower group mean maximal HR of 186.3 bpm and 187.2 bpm respectively. Kramer & Lurie (1964) reported an average mean HR of 191.0 bpm for 44 normal boys (average age from 10.1 to 13.4 years) of varied physical fitness levels. The boys were tested on a "cycle-mill". These investigators also reported a mean maximal HR of 197.0 bpm for six physically fit girls (average age 14.7 years) and 181.0 bpm for five physically unfit girls (average age 13.9 years). Boileau, Bonen, Heyward & Massey (1977) compared maximal performance of 21 boys, aged 11-14 years, and reported a mean maximal HR value of 193.9 bpm for the treadmill test and 186.4 bpm for the bicycle ergometer test. Mean maximal HR values of 188.2 bpm and 186.1 bpm have also been respectively reported for 10-11 year old and 12-13 year old EMH boys tested in a maximal bicycle ergometer test (Maksud & Hamilton, 1974). Mean maximal HR values greater than 200 bpm, 202.5 and 201.7, have also been reported for EMH boys and girls tested on the treadmill (Bar-Or et al., 1971).

Comparing the maximal HR values obtained in this study with those reported in the literature, it would seem that the CFA-Adapted endurance run tested in this study approximates a maximal exercise test. For the subjects tested under the particular setting and procedures of this study, the endurance run was a maximal exercise test. Interestingly, Depauw et al. (1985) have also reported that the heart-rates reached by nine moderately retarded adults during a 12 minute run were rather high, and in some cases, were above predicted maximal values. Unfortunately it is unclear how often the heart-rates were taken during the 12 minute run.

The fact that high exercise intensity levels were sustained by subjects, especially the younger ones, does provide some indication that subjects were motivated and performing at or near maximal capacities. The CFA-Adapted endurance run was definitely very demanding, physically, upon the cardiovascular system of the TMH participants of this study.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The validity of the endurance run as a measure of cardiovascular fitness in children has been questioned and investigated by many researchers, and the results have been conflicting. Using the endurance run with trainable mentally handicapped children and youth posed even greater confounding problems. It is often difficult to motivate such participants to perform and maintain interest in a seemingly meaningless and monotonous task of running around a track. TMH children and youth also have an inadequately developed, or even non-existing, concept of pacing. This study was therefore designed to investigate the validity of the current CFA-Adapted endurance run, as well as increasing the validity of the run by introducing a pacing protocol.

As a result of this study, a number of descriptive and general concluding statements concerning the validity of the CFA-Adapted endurance run, the TMH's performance and heart rate response on the run, as well as the feasibility of using a pacing protocol, can be put forth:

1) The ability of TMH participants to complete the CFA-Adapted endurance run can be effectively enhanced by incorporating a systematic pacing protocol.

2) Apparently, the proposed pacing protocol seemed to be more effective at improving performance of 10-12 year old TMH participants, who had a shorter distance to run than the 13-and-older participants.

3) Trainable mentally handicapped runners who are slow or unable to complete the endurance run independently can benefit positively

from an individualized and systematic pacing-prompting protocol. Results from this study showed that the proposed pacing protocol used in this study can help about 80% of those TMH participants who are having difficulties completing the run.

4) The tremendous intra-individual and inter-individual differences in performance and heart-rate response demonstrate clearly that wide variability exists within the TMH population. Such individual differences are indicative of the differences in levels of motivation, running efficiency, anaerobic involvement, cognitive appreciation of the distance to be run, and most of all, the ability to pace oneself efficiently during the run. All these confounding variables reinforce the contention of this study that if pacing is to be effectively used with the TMH, the paces must be individualized and based on initial performance times.

5) It is not sufficient to teach or provide pacing to TMH participants during practice sessions and then subsequently remove it during testing. Pacing must be an integral part of the testing protocol.

6) Heart rate data collected during the run suggest that the CFA-Adapted endurance run is physically more demanding for 13-and-older males than 10-12 year old participants. It is suspected that the degree of physical stress upon the CV system is correlated to:

   i) the distance that each age group has to complete, and

   ii) the level of motivation required to run the required distance.

7) Under testing conditions similar to those of this study, the CFA-Adapted endurance run approximates a maximal exercise test

when an individualized pacing protocol is utilized.

8) Based on heart-rate data, it can be concluded that the CFA-Adapted endurance run is a valid cardiovascular endurance test for TMH subjects tested in conditions similar to this study.

RECOMMENDATIONS

Too often, the poor performances of trainable mentally handicapped individuals on any fitness test batteries are accepted as 'matter-of-fact'; worse still, good performances are seldom expected. To date, no study has investigated the possible effects that a pacer, or pacing protocol may have upon the TMH's running performance. In addition, no objective data exist to support or refute the claim that endurance runs are valid cardiovascular endurance tests for this population. There is definitely an urgent need to address such questions. Tremendous research possibilities exist in this particular area, which has long been neglected.

The following recommendations are an outcome of the present study, and by no means make up a comprehensive list. The recommendations are thus focused upon the trainable mentally handicapped and their performance on the CFA-Adapted endurance run.

1) The pacing protocol proposed in this study should be tested with a much bigger sample size, with TMH subjects in all three age and sex categories, to determine if such a protocol is indeed effective for all TMH participants or, if in fact it is suitable only for TMH with certain characteristics.

2) The performance and heart rate response of non-MH, mild and trainable mentally handicapped children on the CFA-Adapted endurance should be studied to determine if any differences and/or

similarities exist between the three groups with regards to the mentioned variables. In addition, the effects of pacing upon performance should also be examined with these sub-groups.

3) In this study, the pace times determined for treatment sessions were based on the award level times. Unfortunately, there are many concerns regarding the award times and how they were derived. There is therefore a need to determine an appropriate procedure by which testers or teachers can best determine what paces are most appropriate for individual participants.

4) Faster MH or non-MH peers, siblings and parents can be used as pacers, whenever possible, during practice and testing sessions. Such pacers, however, should be properly instructed as to how to pace, and what pace to set.

5) To fully appreciate and understand the TMH's performance and heart rate response on the CFA-Adapted run, behavioural response patterns during the run should also be examined. Availability of such descriptive data will provide valuable information concerning running pattern and movement efficiency.

6) An attempt should be made to replicate this study, and further studies that address the above recommendations, in the actual school testing environment, with the teachers conducting the test and providing the pacing.

References

American Association for Health, Physical Education and Recreation (1968). Special Fitness Test for the Mentally Retarded. Washington, D. C., AAHPER.

Andrew, G. M., Reid, J. G., Beck S. & McDonald, A. (1979). Training of the developmentally handicapped young adults. Canadian Journal of Applied Sports Science, 4(4), 289-293.

Astrand, P. O. & Ryhming, I. (1954). A nomogram for calculation of aerobic capacity (physical fitness) from pulse rate during submaximal work. Journal of Applied Physiology, 7, 218-221.

Astrand, P. O. & Rodahl, K. (1977). Textbook of Work Physiology. New York: McGraw Hill Book Co.

Bar-Or, O., Skinner, J. S., Bergsteinova, V., Shearburn, C., Royer, D., Bell, W., Hass, J. & Buskirk, E. R. (1971). Maximal aerobic capacity of 6-15 year old girls and boys with subnormal intelligence quotients. Acta Paediat. Scand. Supplement, 217, 108-113.

Boileau, R. A., Bonen, A., Heyward, V. H. & Massey, B. (1977). Maximal aerobic capacity on the treadmill and bicycle ergometer of boys 11-14 years of age. Journal of Sports Medicine, 17(2), 153-161.

Bolonchuk, W. W. (1971). A critical analysis of the AAHPER Youth Fitness Test. A summer research project sponsored by the Louis W. & Maud Hill Family Foundation, St. Paul: Minn. (ERIC document Reproduction Service No. ED 103 414).

Brace, D. K. (1961). Motor fitness of MR boys relative to national age norms. Paper presented to the Research Section, AAHPER National Convention, Atlantic City: New Jersey. (ERIC Document Reproduction Service No. ED 084 758).

Campbell, J. (1973). Physical fitness and the MR: A review of research. Mental Retardation, 11(5), 26-29.

Chausow, S. A., Riner, W. F. & Boileau, R. A. (1984). Metabolic and cardiovascular responses of children during prolonged physical activity. The Research Quarterly, 55(1), 1-7.

Coleman, A. E., Ayoub, M. M. & Friedrich, D. W. (1976). Assessment of the physical work capacity of institutionalized mentally retarded males. American Journal of Mental Deficiency, 80(6), 629-635.

Cooper, K. H, (1968(a)). Aerobics. New York: M. Evans & Co.

Cooper, K. H. (1968(b)). A means of assessing maximal oxygen intake. Journal of American Medical Association, 203(3), 135-138.

Cooper, K. H. (1972). Testing and developing cardiovascular fitness. Journal of Physical Education, March-April, 139-144.

Corbin, C. B. (1972). Relationships between physical working capacity and running performances of young boys. The Research Quarterly, 43(2), 235-238.

Corbin, C. B. (1973). A Textbook of Motor Development. Dubuque : Wm. C. Brown Co., (pp. 86-87).

Crawford, G. L. & Mason, G. P. (1974). Reliability of the CAHPER Fitness Performance Test with junior secondary school boys. Canadian Association for Health, Physical Education & Recreation Journal, 40(3), 12-17.

Cummings, G. R. & Danzinger, R. (1963). Bicycle ergometer studies in children II. Correlation of pulse rate with oxygen consumption. Pediatrics, 32(2), 202-208.

Cummings, G. R., Goulding, D. & Baggley, G. (1971). Working capacity of deaf, visually and mentally handicapped children. Archives of Disease in Childhood, 46, 490-494.

Dahlgren, W. J. (1982). The Canadian Fitness Award: Its development and use. Canadian Association for Health, Physical Education & Recreation Journal, 49(1), 3-5.

Depauw, K. P., Mowatt, M. & Hiles, M. (1985). Cardiovascular endurance of mentally retarded adolescents as measured by the 12 minute run and bicycle ergometer. (Abstract from the 5th. International Adapted Physical Activity Symposium, Toronto. (pp. 95)).

Dishman, R. K. (1978). Aerobic power, estimation of physical activity, and attraction to physical activity. The Research Quarterly, 49(3), 285-292.

Docherty, D. & Collis, M. L. (1976). The CAHPER Fitness Performance Test revisited. Canadian Association for Health, Physical Education & Recreation Journal, 42(6), 35-38.

Docherty, D. & Quinney, H. A. (1984). Evaluating physical fitness with reference to the functional capacities of muscle. Canadian Association for Health, Physical Education & Recreation Journal, 50(4), 15-18.

Doolittle, T. L. & Bigbee, R. (1968). The 12 minute run-walk: A test of cardiorespiratory fitness of adolescent boys. The Research Quarterly, 39(3), 491-495.

Dorociak, J. J. & Nelson, J. K. (1983). The 1 mile and 2 mile runs as measures of cardiovascular fitness in college women. Journal of Sports Medicine, 23(2), 322-325.

Eriksson, B. & Saltin, B. (1974). Muscle metabolism during exercise in boys aged 11 to 16 years compared to adults. Acta Paediat. Belgica, 28, 257-265.

Fait, H. F. & Kupferer, H. J. (1956). A study of 2 motor achievement tests and its implications in planning physical education activities for the mentally retarded. American Journal of Mental Deficiency, 60(4), 729-732.

Falls, H. B. (1966). Estimation of maximum oxygen uptake in adults from AAHPER Youth Fitness items. The Research Quarterly, 37, 192-210.

Fitness and Amateur Sport. (1985). Canada Fitness Award: Adapted for use by TMH youth. Ottawa, Canada.

Findlay, H. A. (1981). Adaptations to the Canada Fitness Award for special populations: A report from phases 1 & 2. Canadian Association for Health, Physical Education & Recreation Journal, 48(1), 5-12.

Findlay, H. A. (1983). An analysis of the Canada Fitness Award: Adapted for use by TMH youth. Unpublished report.

Findlay, H. A., Watkinson, E. J., Dahlgren, W. J., Evans, J., Lafrenier-Joannette, L. & Bothwell-Meyers, C. (1984). Canada Fitness Award: How to use it; How to change it. Canadian Association for Health, Physical Education & Recreation Journal, 50(5), 10-16.

Fox, E. L. & Mathews, D. K. (1981). The Physiological Basis of Physical Education and Athletics. Philadelphia: Saunders College.

Gilliam, T., Freedson, P., Geenen, D. & Shahraray, B. (1981). Physical activity patterns determined by heart rate, monitoring in 6-7 year old children. Medicine & Science in Sports, 13(1), 65-67.

Hayden, F. J. (1964). Physical fitness for the mentally retarded: A manual for teachers and parents. Metropolitan Toronto Association for Retarded Children, Toronto.

Jackson, A. S. (1975). An evaluation of the AAHPER Youth Fitness Test. Paper presented at the Evaluation section of the annual meeting of AAHPER, Atlantic City, N. Jersey. (ERIC Document Reproduction Service No. ED 103 411).

Jette, M., Campbell, J., Mongeon, J. & Routhier, R. (1976). The Canadian Home Fitness Test as a predictor of aerobic work capacity. Canadian Medical Association Journal, 114, 680-682.

Johnson, L. & Londeree, B. (1976). Motor fitness testing manual for the moderately mentally retarded. Washington, D. C.

Karvonen, J., Chwalbinska-Moneta, J. & Saynajakangas, S. (1984). Comparison of heart rates measured by ECG and Microcomputer. The Physician and Sportsmedicine, 12(6), 65-69.

Katch, F. I., Pechar, G. S., McArdle, W. D. & Weltman, A. L. (1973). Relationship between individual differences in a steady pace endurance running performance and maximal oxygen intake. The Research Quarterly, 44(2), 206-215.

Krahenbuhl, G. S., Pangrazi, R. P., Petersen, G. W., Burkett, L. N. & Schneider, M. J. (1978). Field testing of cardiorespiratory fitness in primary school children. Medicine & Science in Sports, 10(3), 208-213.

Kramer, J. D. & Lurie, P. R. (1964). Maximal exercise tests in children. American Journal of Diseases in Children, 108(3), 283-297.

Londeree, B. & Johnson, L. (1974). Motor fitness of TMR vs EMR and normal children. Medicine and Science in Sports, 6(4), 247-252.

Maksud, M. G. & Hamilton, L. H. (1974). Physiological responses of EMR children to strenous exercise. American Journal of Mental Deficiency, 79(1), 32-38.

Malhotra, M. S., Gupta, J. S. & Rai, R. M. (1963). Pulse count as a measure of energy expenditure. Journal of Applied Physiology, 18(5),994-996.

Marshall, J. D. (1981). Energy expenditure in children. Unpublished report, University of Alberta, Edmonton.

Marshall, J. D. (1982). Exercise intensity in Elementary School Physical Education Classes. M.Sc. Thesis, University of Alberta, Edmonton.

Massicotte, D. & Macnab, R. (1974). Cardiorespiratory adaptations to training at specified intensities in children. Medicine & Science in Sports, 6(4), 242-246.

McArdle, W. A., Katch, F. I. & Katch, V. L. (1981). Exercise Physiology: Energy, Nutrition and Human Performance. Philadelphia: Lea & Febiger.

Metz, K. F. & Alexander, J. F. (1970). An investigation of the relationship between maximum aerobic capacity and physical fitness in 12-15 year old boys. The Research Quarterly, 41, 75-81.

Moon, M. S. & Renzaglia, A. (1982). Physical fitness and the mentally retarded: A critical review of the literature. Journal of Special Education, 16(31), 269-287.

Morehouse, L. E. & Miller, A. T. (1976). Physiology of Exercise. St. Louis: C. V. Mosby Co. (pp. 152-153).

Nagle, F., Robinhold, D., Howley, E., Daniels, J., Baptista, G. & Stoedefalke, K. (1970). Lactic acid accumulation during running at submaximal aerobic demands. Medicine & Science in Sports, 2, 182-186.

Nordgren, B. (1970). Physical capabilities in a group of mentally retarded adults. Scand. Journal of Rehab. Medicine, 2, 125-132.

Peries, V. P. (1976). Fitness testing and evaluation procedures for mentally retarded children. Journal for Special Educators of the Mentally Retarded, 12(3), 192-195.

Rarick, G. L., Widdop, J. H. & Broadhead, G. D. (1970). The physical fitness and motor performance of educable mentally retarded children. Exceptional Children, 35, 509-519.

Reid, G., Montgomery, D. L. & Seidl, C. (1985). Performance of mentally retarded adults on the Canadian Standardized Test of Fitness. Canadian Journal of Public Health, 76(3), 187-190.

Seaman, J. A. & Depauw, K. P. (1982). The New Adapted Physical Education: A Developmental Approach. California: Mayfield Publish. Co.

Sengstock, W. L. (1966). Physical fitness of mentally retarded boys. The Research Quarterly, 37(1), 113-120.

Sheehan, G. A. (1975). Dr. Sheehan on Running. Mountain View: World Publishers.

Shephard, R. J. (1972). Man Alive: The Physiology of Physical Activity. Springfield: Charles C. Thomas (pp 374-412).

Sherrill, C. (1981). Adapted Physical Education & Recreation: A Multidisciplinary Approach. Dubuque: Wm. C. Brown.

Smith, C. D. (1972). Fitness testing: Questions about how, why and with what. Journal of Health, Physical Education & Recreation, 43, 37-38.

Sonstroem, R. (1974). Attitude testing examining certain physiological correlates of physical activity. The Research Quarterly, 45, 93-103.

Speakman, H. G. (1977(a)). The measurement of motor fitness in trainable mentally retarded children. Canadian Association for Health, Physical Education & Recreation, 43(5), 30-35.

Speakman, H. G. (1977(b)). Physical fitness of the mentally retarded: A brief survey of the literature. Canadian Journal of Applied Sports Science, 2, 171-176.

Stein, J. U. (1965). Physical fitness of mentally retarded boys relative to national age norms. Rehab. Literature, 26(7), 205-208.

Wagner, H. D. (1967). The effects of motivation and repeated trials on physical proficiency test performance of educable mentally retarded girls. Dissertation Abstracts, 28:9 - A:3493-3494.

APPENDIX A

Percentages of Completion on the CFA-Adapted Endurance Run

Percentages of completion on the CFA-Adapted endurance run from normative data obtained on 3,172 TMH participant across Canada (Findlay, 1983)

FEMALES

Total number of participants = 1,250

Age Group	No. of Subjects	% Completion
7 - 9	214	26.00
10 - 12	300	17.30
13 & older	979	6.03

MALES

Total number of participants = 1,922

Age Group	No. of Subjects	% Completion
7 - 9	240	24.20
10 - 12	405	20.00
13 & older	1,253	11.65

APPENDIX B

Award Level Times & Criterion Times

Award Level Times and Criterion Times for the CFA-Adapted Endurance run

Endurance Run (minutes and seconds)			
Standard By Age	600 m 6–9 Yrs	1200 m 10–12 Yrs	2000 m 13 Yrs and up
		FEMALE	
Excellence	5:34	7:23	13:09
Gold	5:51	8:09	14:10
Silver	6:20	8:53	15:15
Bronze	7:02	10:26	15:58
		MALE	
Excellence	4:44	8:08	10:54
Gold	5:16	8:54	11:33
Silver	5:53	9:49	13.02
Bronze	6:30	11:06	14:45

Criterion Times For Endurance Run

NOTE: Participants must have a time equal to or lower than the criterion for each 200m in order to continue.

	6-9 years boys	6-9 years girls	10-12 years boys	10-12 years girls	13 and up boys	13 and up girls
200 m	2:46	2:30	2:07	2:07	1:05	1:58
400 m	5:39	5:03	4:06	4:21	3:25	3:56
600 m	STOP		5:58	6:22	5:13	6:16
800 m			8:16	8:40	7:10	8:31
1000 m			10:50	11:25	9:18	10:50
1200 m			STOP		10:26	13:13
1400 m					11:58	14:16
1600 m					13:39	15:20
1800 m					14:12	15:57
2000 m					STOP	

(Source : The Canada Fitness Award-Adapted for TMH youth (1985), Fitness and Amateur Sport, Ottawa, Canada.)

APPENDIX C

Letter and Consent Form

University of Alberta
Edmonton
Canada T6G 2H9

Department of
Physical Education and Sport Studies
P-421 Universiade Pavilion

May 8, 1985

Dear Parent:

The Canada Fitness Award (CFA) was officially launched in 1970 by Fitness and Amateur Sports to assess and motivate Canadian children and youth toward higher fitness levels. In 1983 the CFA was formally adapted for trainable mentally handicapped children and youth with the same objectives.

Normative data collected on 3,172 TMH children and youth across Canada indicates that the TMH performance on the endurance run, which is a cardiovascular endurance test, were below those expected of individuals with minimal levels of fitness. A research study is hence being proposed at the University of Alberta to study the running test and to investigate ways of encouraging better performance. It is our belief that TMH children are capable of better performance if they have someone to pace and race with them.

The proposed study is scheduled to be conducted in May and June, 1985. The study will be conducted at the University of Alberta's Pavilion once a week for 5 weeks. Your child has been selected as a possible subject for the study and we are requesting your consent for your child's participation in the study. Please be assured that all precautions for your child's well-being are being taken into consideration. All testing instructors are trained and experienced at handling TMH children. Should your child display any discomfort or stress during the run, we will terminate the test. If you have further questions regarding the study, please call Sock Koh at 432-5502 (O) or 439-0254 (H).

Your assistance in making the study possible will be greatly appreciated. Thank you.

Yours faithfully,

Dr. E.J. Watkinson, Research Advisor

Sock M. Koh., Research Assistant

Consent For Participation in the CFA Endurance Run

I, ______________________________, the parent/guardian of ______________________ authorize the said Examiner, Sock M. Koh, of the University of Alberta, Department of Physical Education and Sport Studies, to administer and conduct an Endurance Run (1200m for 10-12 yr. olds; 2,000m for 13 and above) for research purposes.

I understand that my child/ward will run the distance specified for his/her age during the pre-test of the pilot study. I also understand that if my child/ward is assigned to a treatment group, he/she will run with an adult pacer-prompter over the specified distance. During the run my child/ward will be asked to discontinue the test if he/she does not fulfill the criteria time set for every 200m. Alternatively, my child/ward can choose not to complete the run. I understand too that the test will be discontinued if he/she becomes distressed in any way or develops any abnormal responses, whichever of the above occurs first.

I acknowledge that I have read this form and in agreeing to allow my child/ward to participate in the Endurance run, I waive any legal recourse against the examiner, the Department of Physical Education and Sport Studies and the University of Alberta from any and all claims from possible injuries resulting from the run. This waiver shall be binding upon my heirs and my personal representatives.

I understand too that the data collected from the study will be used by the University of Alberta for research purposes in a form that will not allow personal identification.

Date ______________________ Signature ______________________________

APPENDIX D

Pacing Times

Pacing times (min.) determined for Experimental Subjects

Pace times for 10-12 year olds

Sub-expt. groups	T1		T2		T3	
	M	F	M	F	M	F
Group A1	14:25		14:25		14:25	
Group B1	12:42		12:42		12:42	
Group C1	10:26	11:06	10:26	11:06	10:26	11:06
Group D1	8:53	9:49	8:53	9:49	8:53	9:49
Group E1	8:09	8:54	8:09	8:54	8:09	8:54
Group F1			7:23	8:08	7:23	8:08
Group G1	(Time taken to complete run at any session - 1:00min)					

M : Males F : Females

---→ completed distance at determined pace

⟶ did not complete distance at determined pace

Pace times for 13-and-older males

Sub-experimental groups	T1	T2	T3
Group A2	18:57	18:57	18:57
Group B2	17:30	17:30	17:30
Group C2	14:45	14:45	14:45
Group D2	13:02	13:02	13:02
Group E2	11:33	11:33	11:33
Group F2		10:54	10:54
Group G2	(Time taken - 1:00 min)		

APPENDIX E

A Sample Pace Card

Pace times for 10-12 year old females (Group F1)

Pace : 8:08 min.

	Pace-keeper #1	Pace-keeper #2
100m	0:40 min	
200m		1:20 min
300m	2:00	
400m		2:40
500m	3:20	
600m		4:00
700m	4:40	
800m		5:20
900m	6:00	
1,000m		6:40
1,100m	7:20	
1,200m		8:00

APPENDIX F

Change of Pace Times & Levels across Treatment Sessions

Change of pace times & levels across Treatment sessions for Experimental Subjects

10-12 year old experimental group

Subject	Treatment 1	Treatment 2	Treatment 3
SE1	5:12 (G1)	ABS	6:06 (G1)
SE2	5:15 (G1)	5:15 (G1)	5:15 (G1)
SE3	5:48 (G1)	5:21 (G1)	5:52 (G1)
SE4	ABS	8:08 (F1)	7:00 (G1)
SE5	8:53 (D1)	8:09 (E1)	8:53 (D1)
SE6	10:26 (C1)	8:53 (D1)	ABS
SE7	11:06 (C1)	9:49 (D1)	9:49 (D1)
SE8	14:25 (A1)	8:53 (D1)	8:53 (D1)
SE9	14:25 (A1)	11:06 (C1)	11:06 (C1)

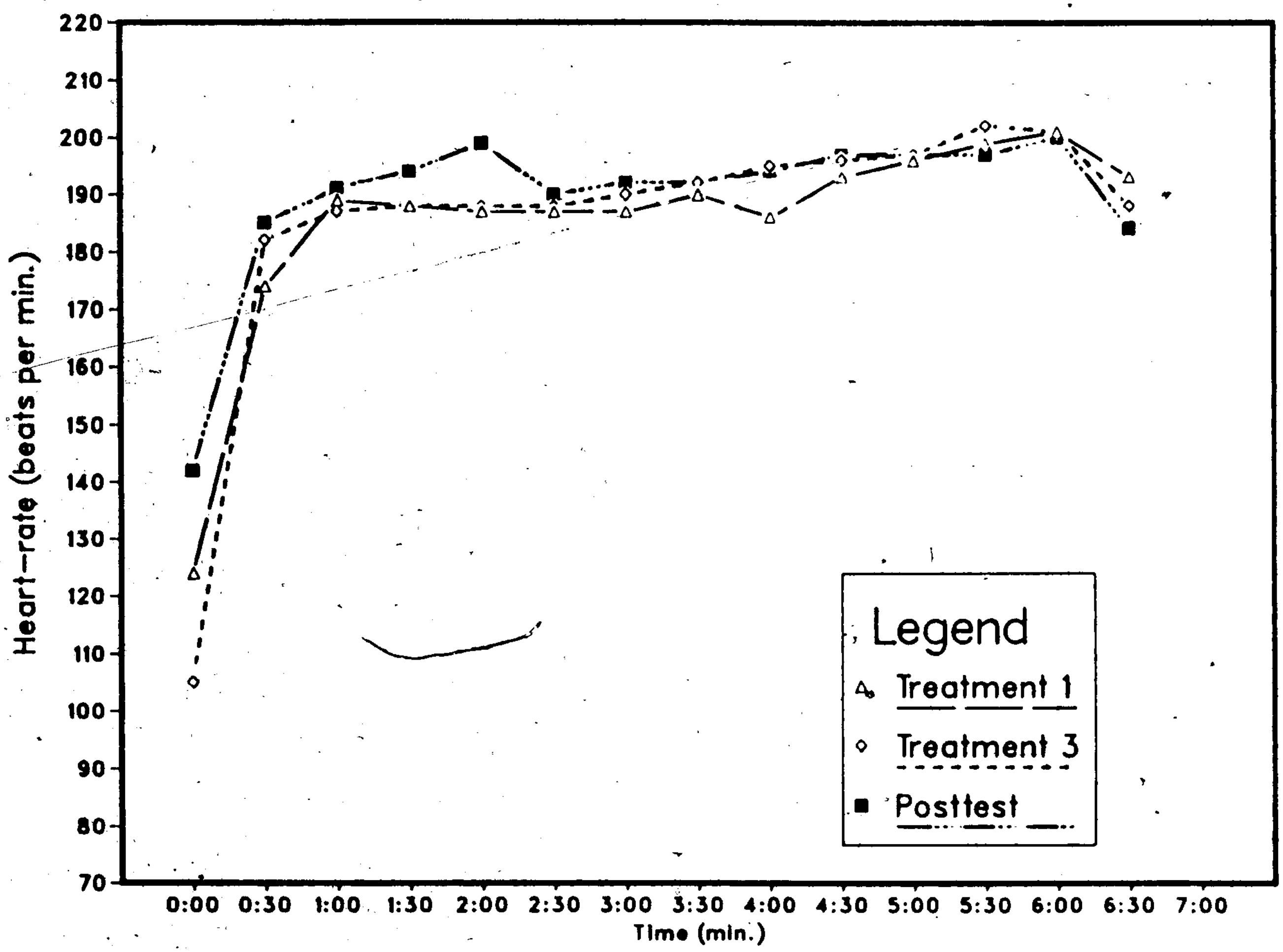
13-and-older experimental group

Subject	Treatment 1	Treatment 2	Treatment 3
SE10	11:33 (E2)	11:33 (E2)	11:33 (E2)
SE11	11:33 (E2)	13:02 (D2)	11:33 (E2)
SE12	14:45 (C2)	13:02 (D2)	11:33 (E2)
SE13	17:30 (B2)	17:30 (B2)	17:30 (B2)
SE14	18:57 (A2)	ABS	18:57 (A2)
SE15	18:57 (A2)	17:30 (B2)	17:30 (B2)
SE16	18:57 (A2)	17:30 (B2)	17:30 (B2)

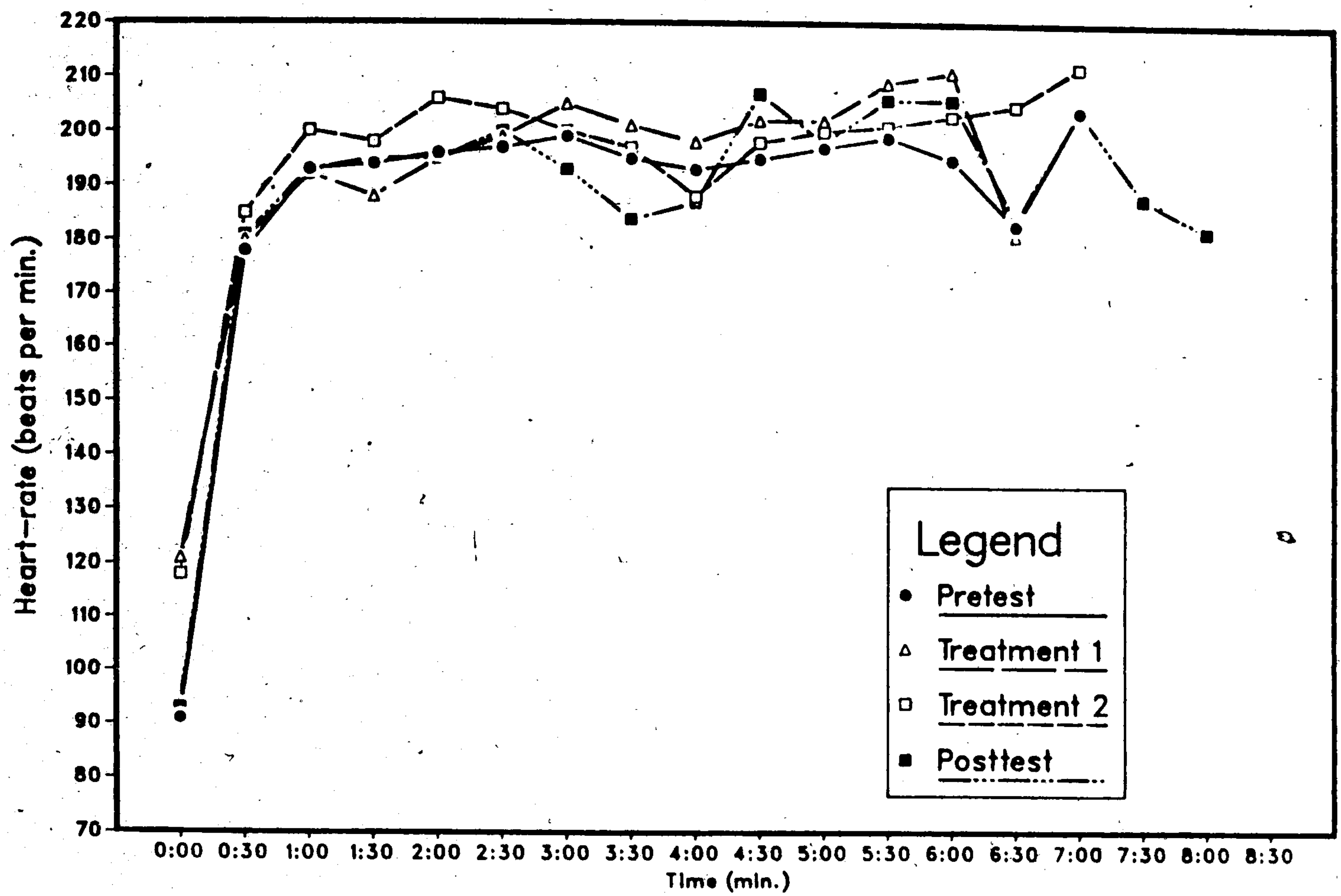
APPENDIX G

Heart Rate Data Points of Individual Subjects

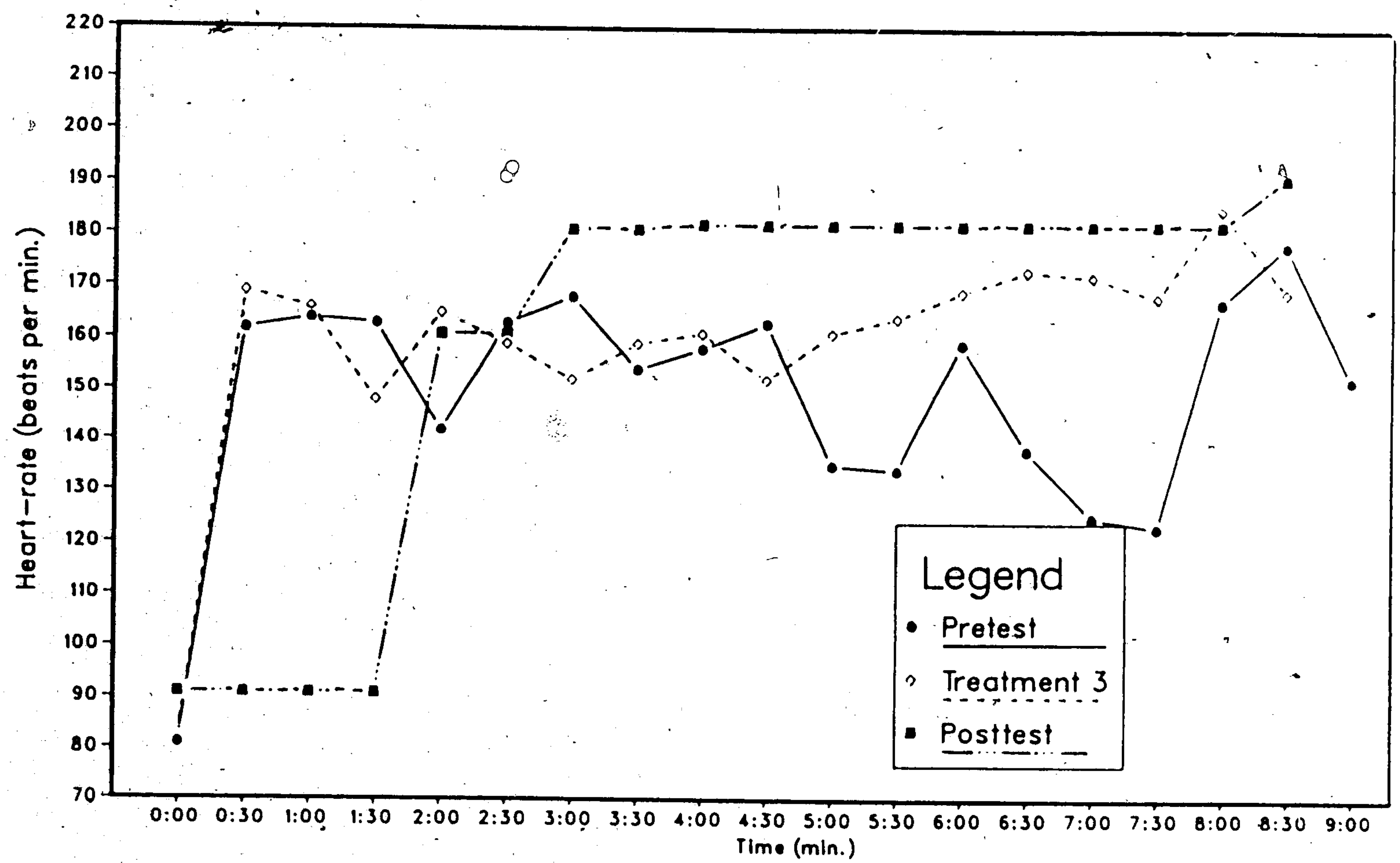
Figure 11. Heart-rate data points of Subject SE2



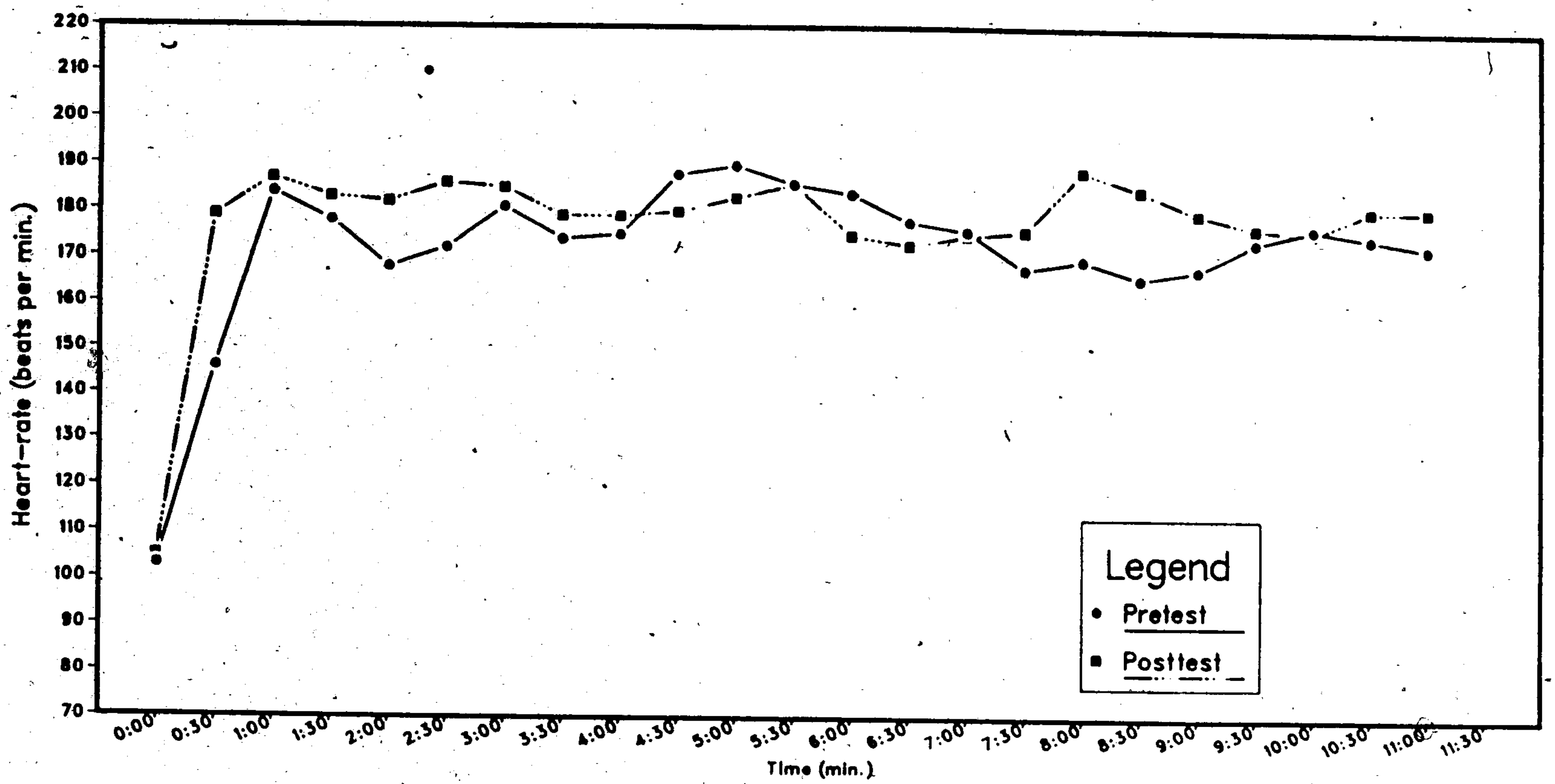
Heart rate data points of Subject SE2



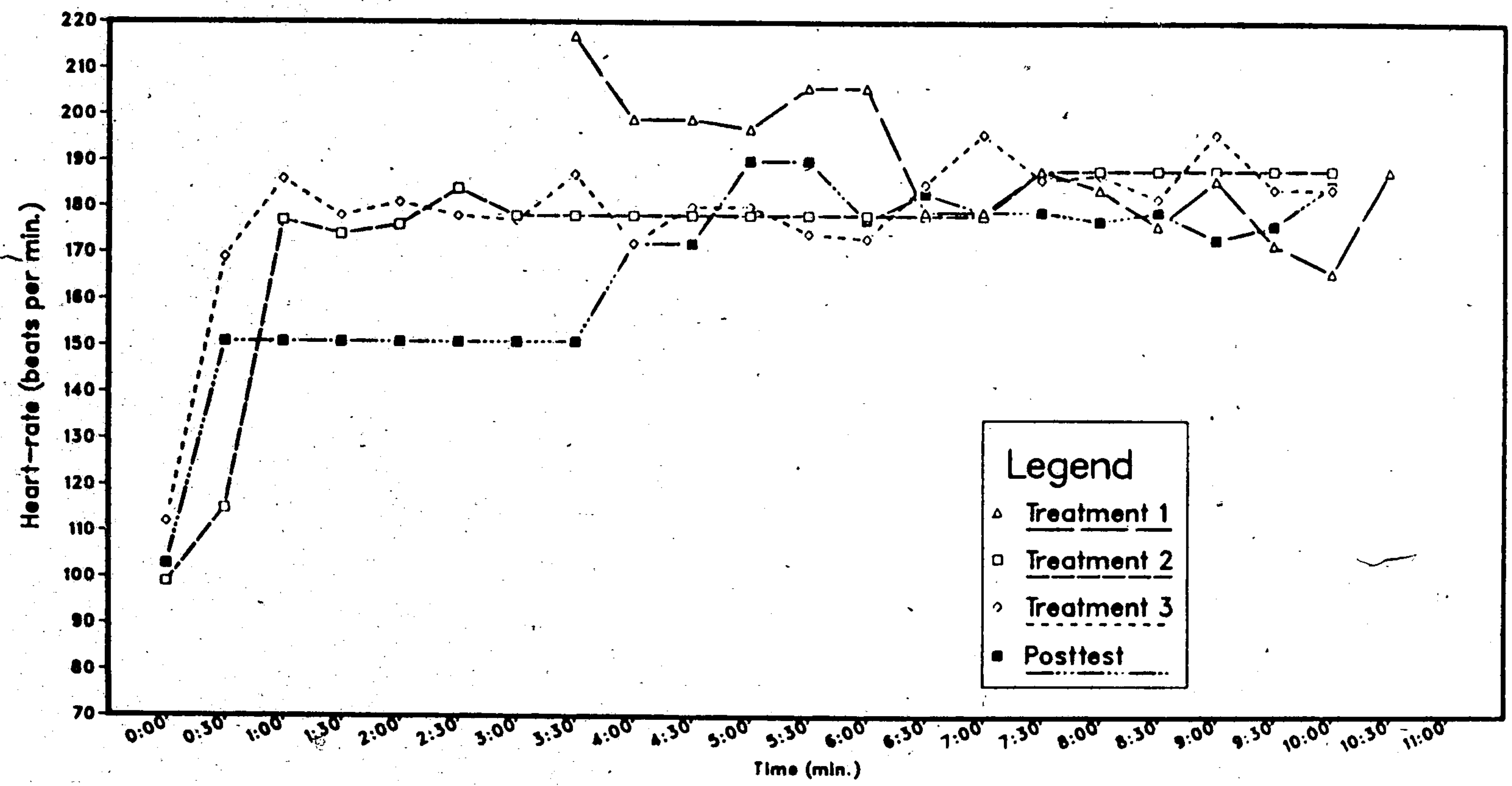
Heart rate data points of Subject SE3



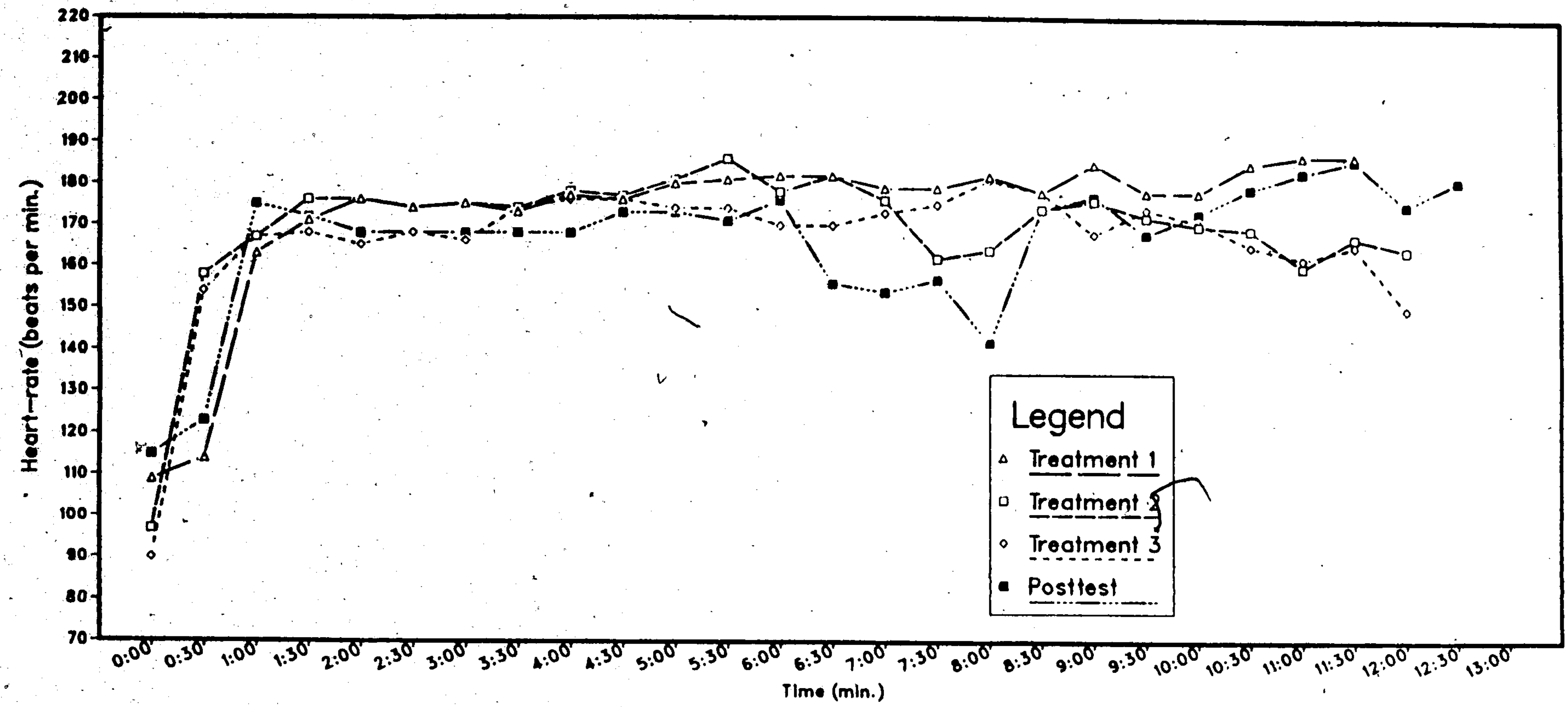
Heart rate data points of Subject SE4



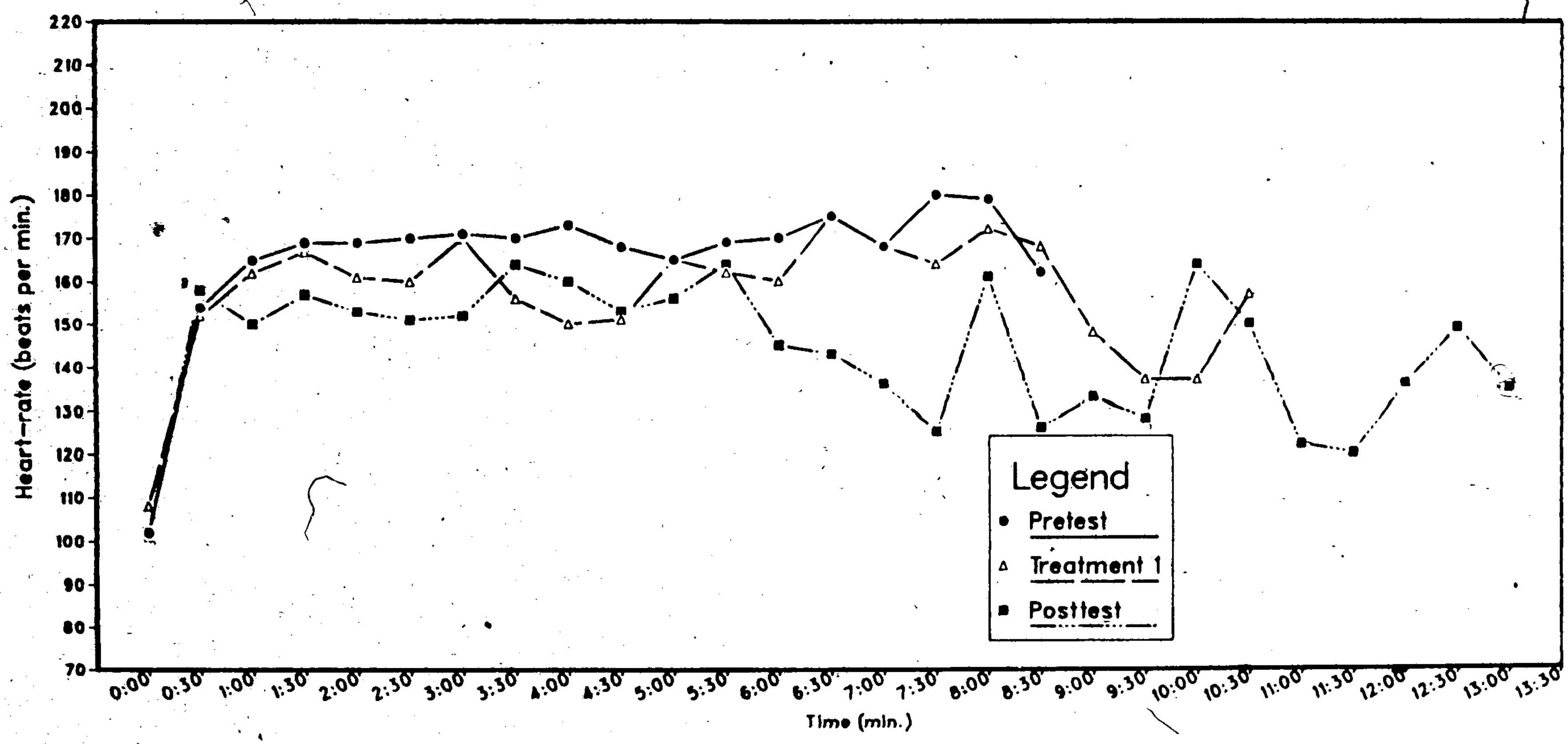
Heart rate data points of Subject SE6



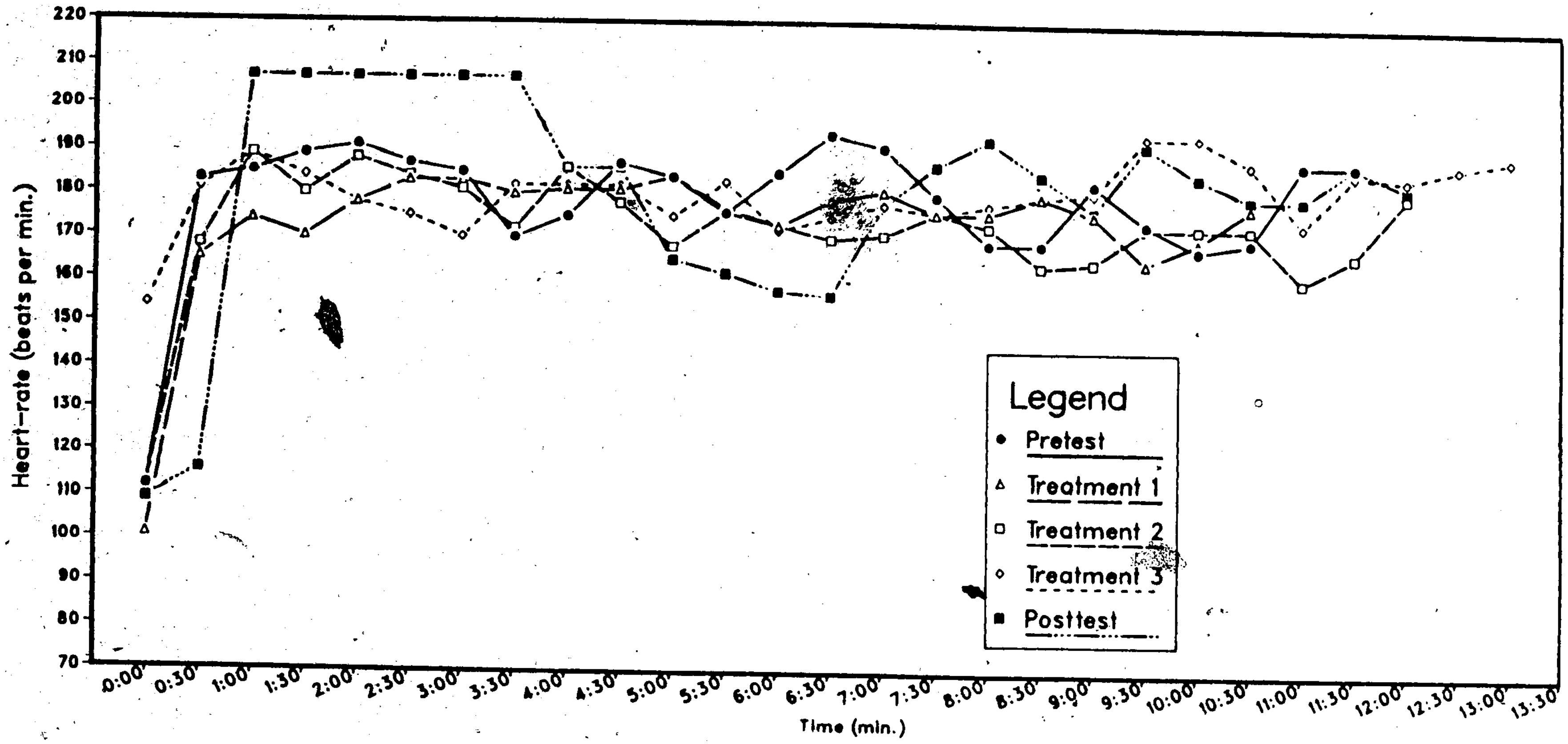
Heart rate data points of Subject SE8



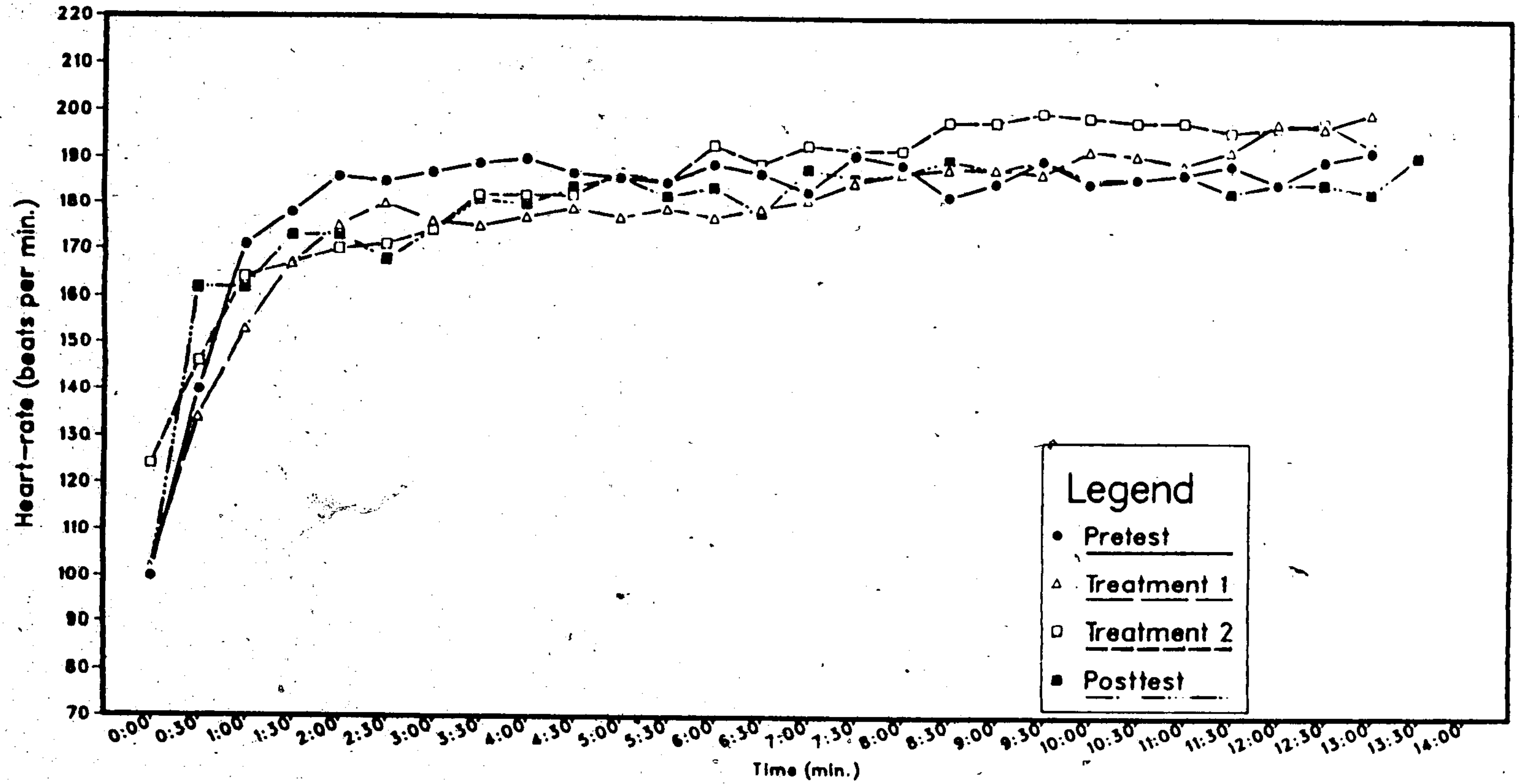
Heart rate data points of Subject SE9



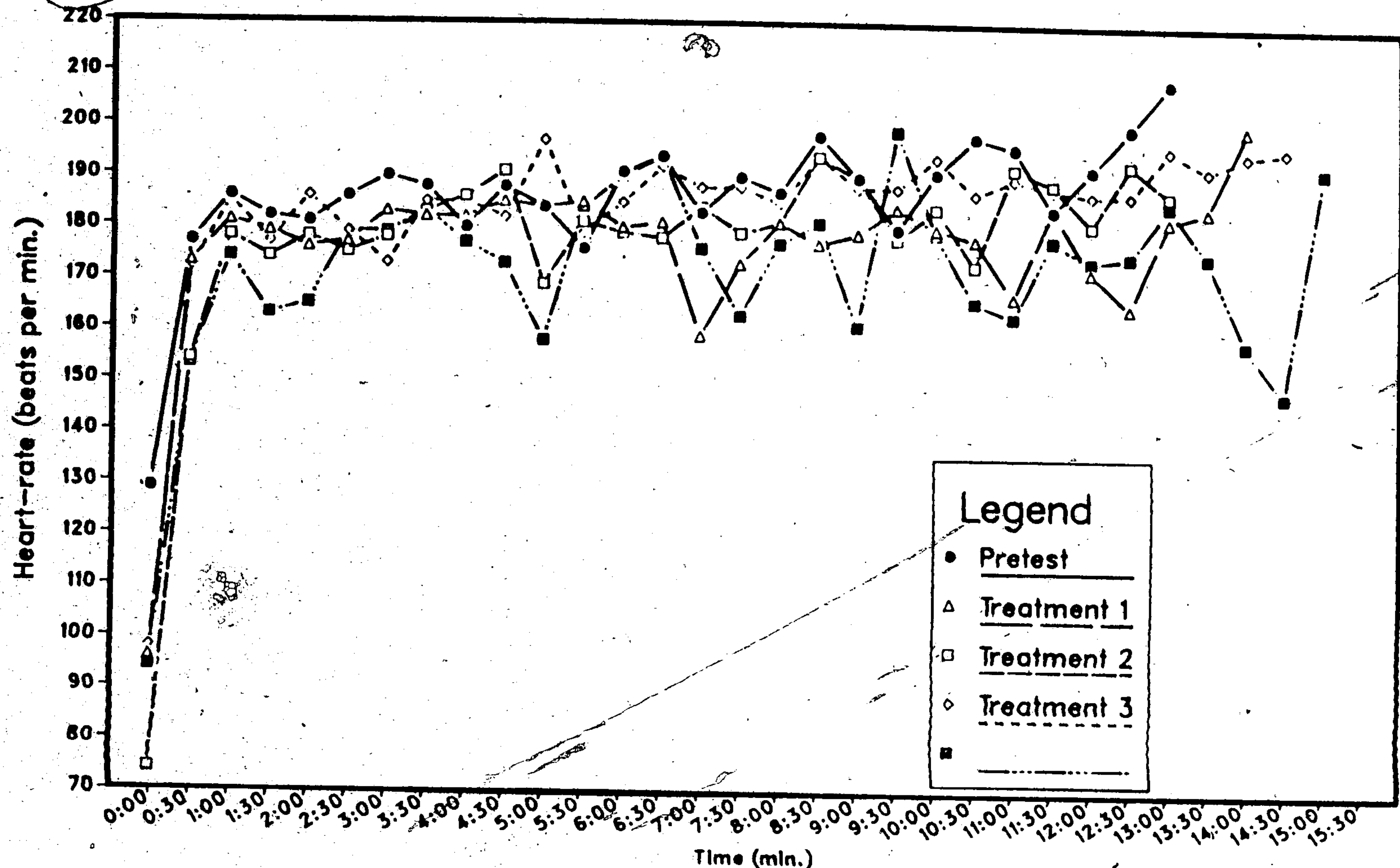
Heart rate data points of Subject SC3



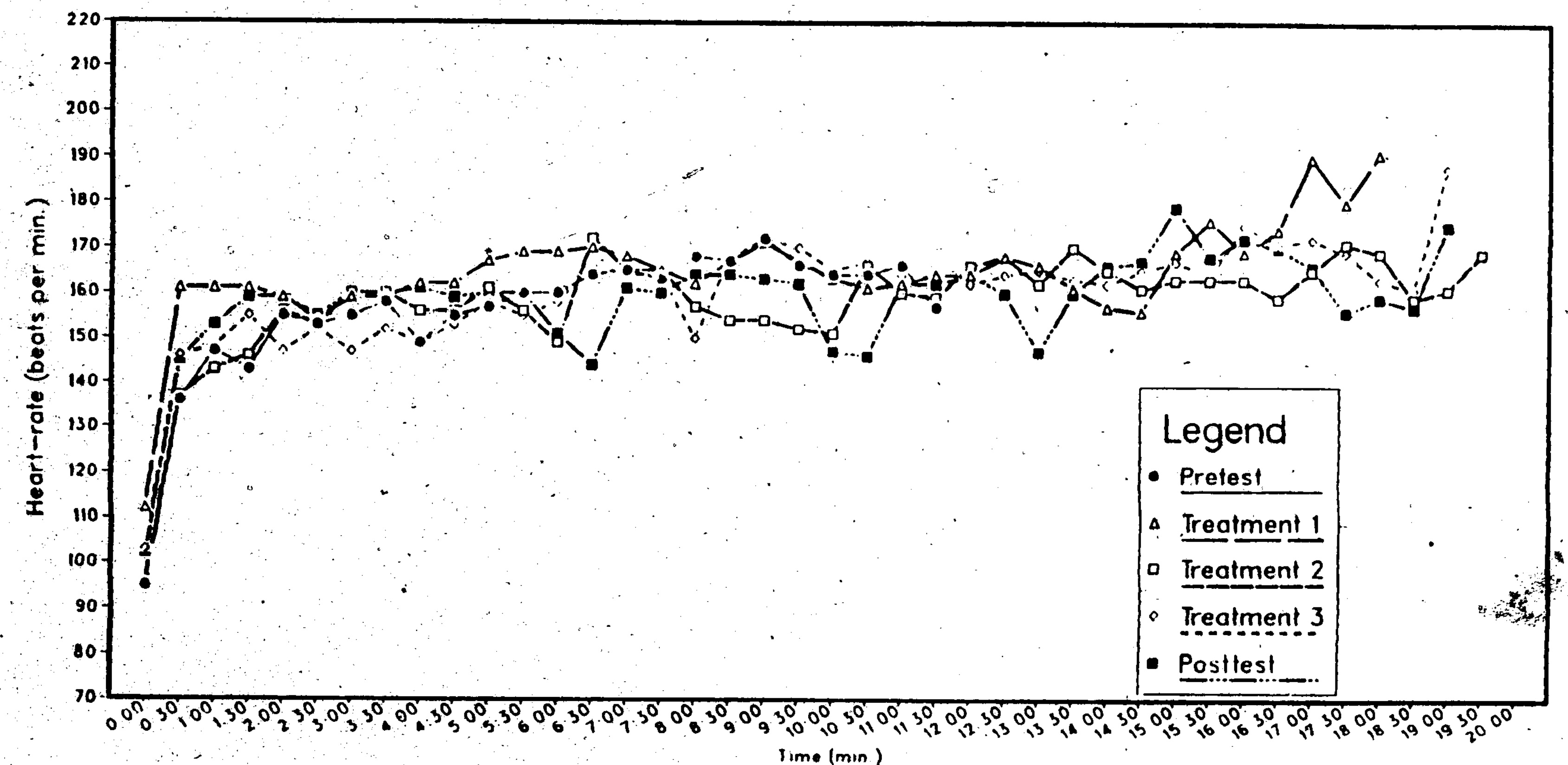
Heart rate data points of Subject SC4



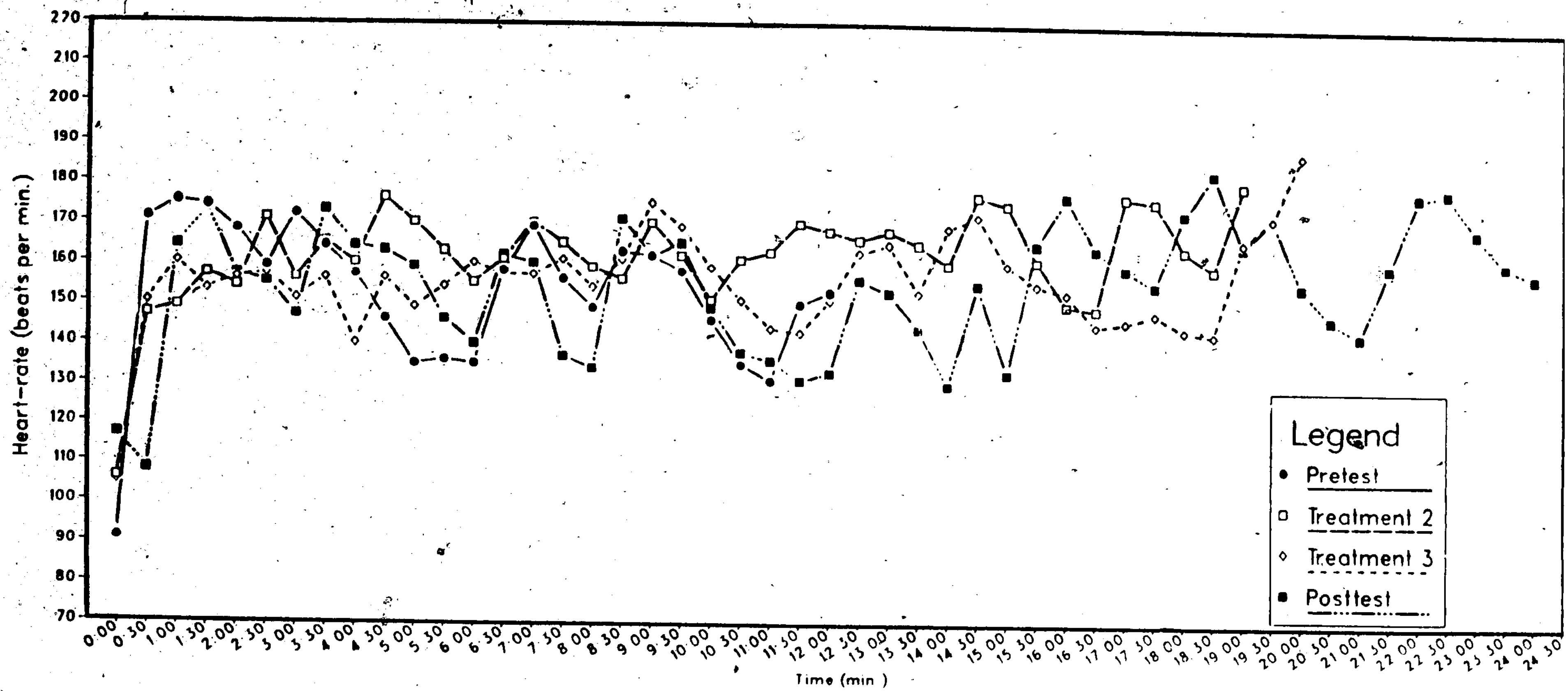
Heart rate data points of Subject SE10



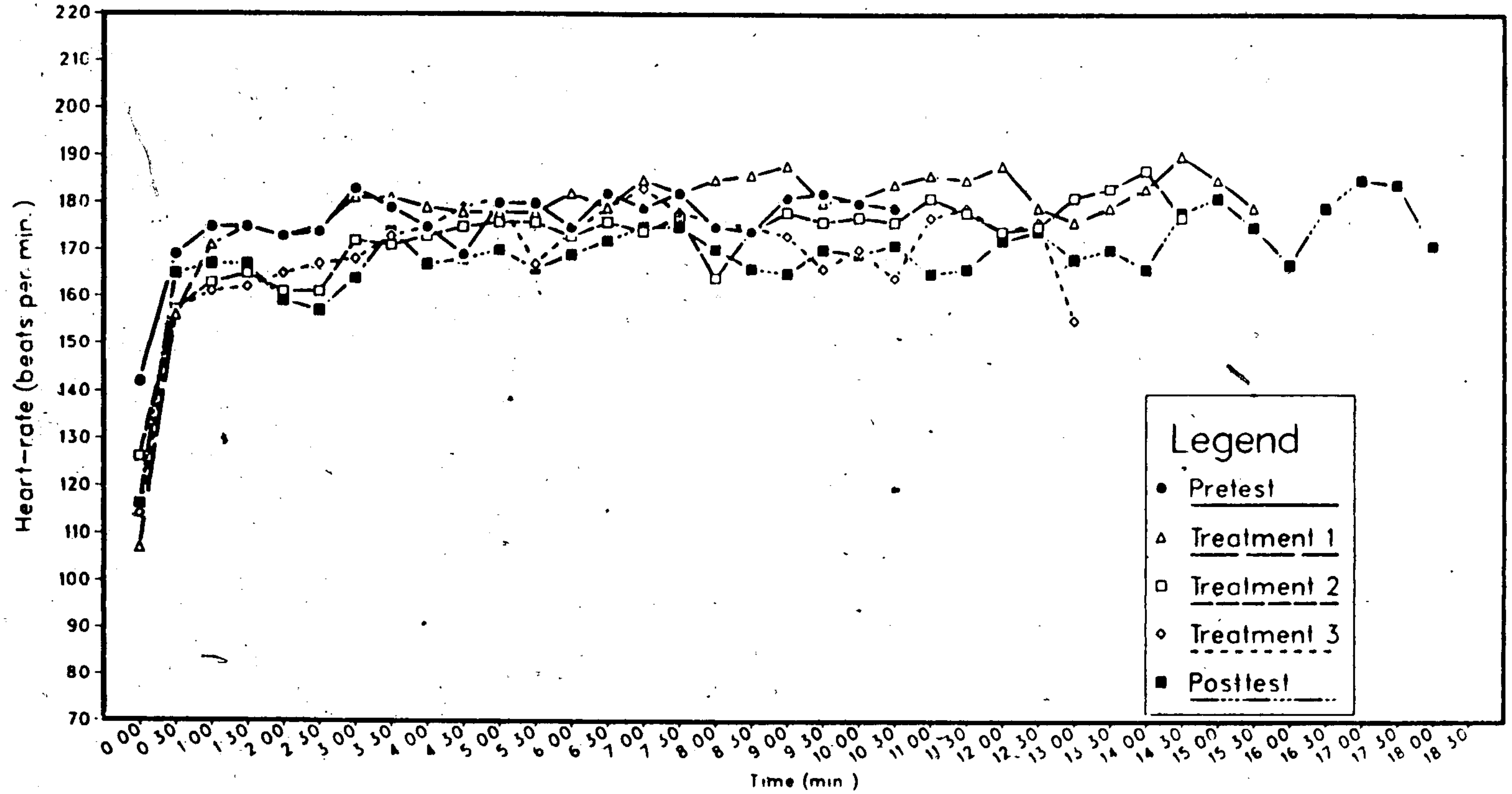
Heart rate data points of Subject SE11



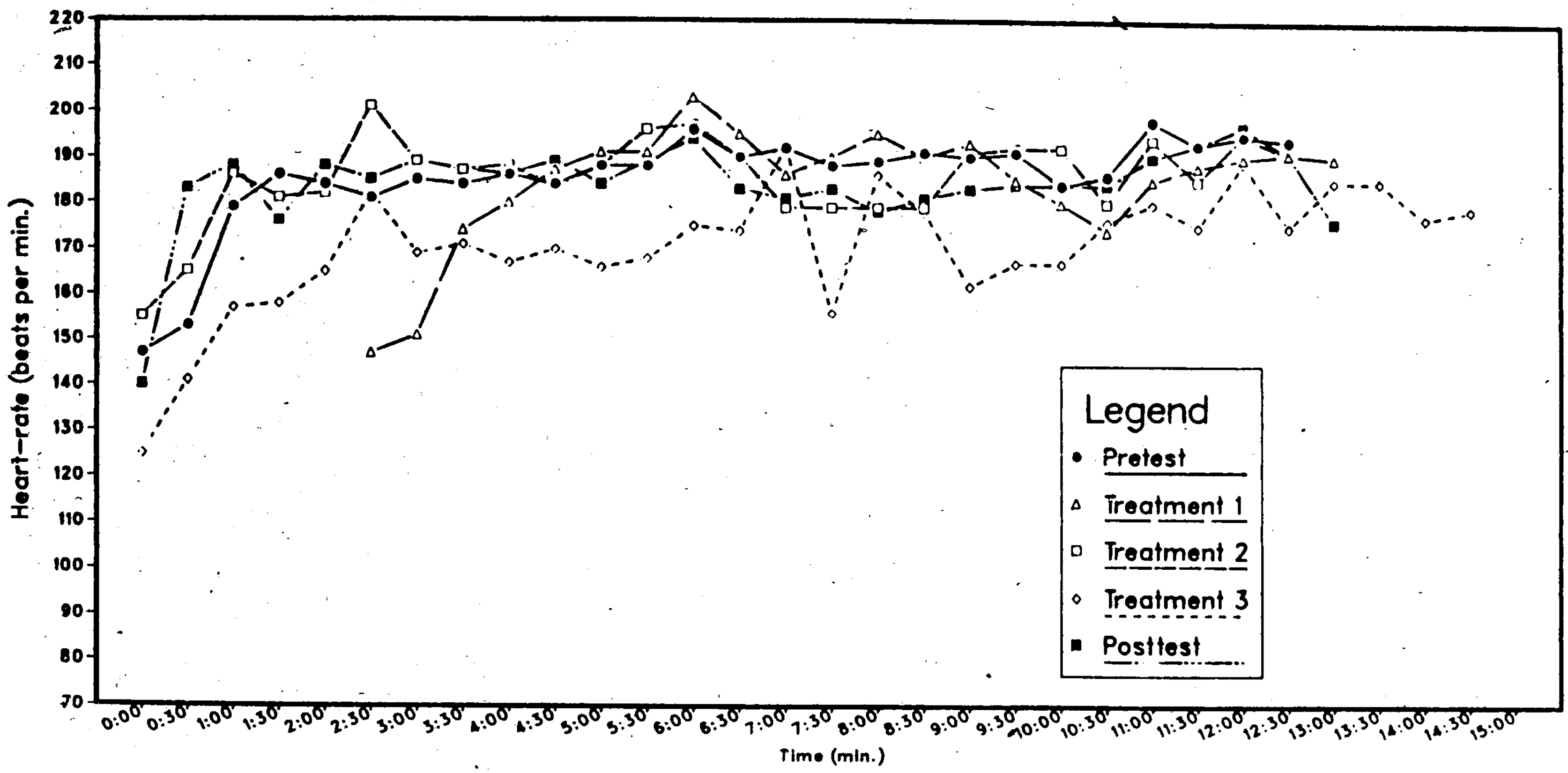
Heart rate data points of Subject SE13



Heart rate data points of Subject SE14



Heart rate data points of Subject SE16



Heart rate data points of Subject SC5