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Investigation of responses of age-group swimmers during training

Roaf, W. Alan M.

AN INVESTIGATION
OF RESPONSES OF AGE-GROUP SWIMMERS
DURING TRAINING

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in the

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****

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W. Alan M. Roaf

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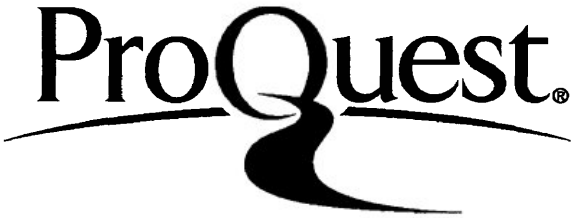

ABSTRACT

Title of Thesis: An investigation of responses of age-group swimmers during training

W. Alan M. Roaf: Master of Science in the Theory of Coaching, 1982

Thesis Advisor: Dr. Brent S. Rushall
Professor
School of Physical Education and Outdoor Recreation
Lakehead University

The purpose of this study was to monitor a series of multi-disciplinary indices associated with swimming performance in age-group swimmers throughout a period of serious training. Three female and three male members of the Thunder Bay Thunderbolts Swim Club, Thunder Bay, Ontario were the subjects of this nine week investigation. The test protocol measured 1) height, 2) weight, 3) skinfold measurements, 4) resting heart rate, 5) resting blood pressures, 6) hemoglobin, 7) hematocrit, and 8) M.C.H.C. A sociological scale, a psychological inventory, and a stress index were included. Graphical analyses were used. Changes had to be visually obvious to be recognized. The results showed that 1) variations were unique to the individual subjects, 2) individual responses were independent of the training load, 3) intra-subject parameters varied within ranges unique to each individual, 4) individual, rather than group assessments, may be necessary, 5) longitudinal testing data is necessary , 6) testing protocols unique to an individual athlete might be specified, and 7) ranges of tolerance rather than finite data points may more accurately measure an athlete's adaptation to a state of training.

ACKNOWLEDGEMENTS

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Chapter 1

INTRODUCTION

Statement of the Problem

The purpose of this investigation was to monitor a series of multi-disciplinary indices associated with swimming performance in age-group swimmers throughout a period of serious training.

Significance of the Study

Evaluating training programmes is essential to an athlete's progress, as it enables the coach to monitor rates of improvement, and suggests possible sites for improving efficiency (Dick, 1980). Well-controlled experiments using sophisticated equipment and procedures can be difficult and time consuming to manage (Carlile, 1961). Therefore, coach-implementable tests that are functional, easy to administer, and inexpensive may be of assistance to a coach of age-group swimmers. This thesis attempted to identify such tests.

The credibility of any test primarily depends on whether the coach can use the results to guide his or her athlete to higher performance levels. Since the essential components of success in sport are the biomechanical, physiological, and psychological characteristics of an athlete (Dick, 1980), simple tests that monitor changes in these factors could be informative. Sociological characteristics may also be helpful. Measurements that are not specific to changes in the athlete's form could be eliminated from the current battery of tests. This thesis attempted to identify any nonspecific tests.

The practicality of tests should be emphasized. Coaches and athletes need information that can help them in their competitive activities.

Measurements for the sake of research alone may create a resentment towards future tests. Efficient time utilization should also be realized, since extensive testing procedures could use up all-important training time. This thesis utilized practical and quickly administered monitoring procedures.

In this study, certain physiological, psychological, and sociological parameters of age-group swimmers were explored. Test items that were common to the group as well as specific to the individual were documented. The periodicity of any cycles were indicated, and any possible inter-relationships were suggested. Although this study was exploratory, its multidisciplinary nature is original. Its focus on the specific needs of a coach is practical. Directions for future investigation were indicated.

By observing athletes carefully, and by noting those changes which may prove to be useful and objective measures of the state of training stress, the coach may ultimately be able to predict the adaptation of athletes. This would be a contribution to training science (Carlile, 1962). Therefore, the identification of functional and easily administered tests that enable the coach to monitor changes in the status of athletes will enhance the methodology of coaching.

Delimitations

1. This study was delimited to those athletes undergoing a training program as directed by the Head Coach of the Thunderbolts Swim Club, Thunder Bay, Ontario. The group of subjects was comprised of three girls and three boys who were the club's top performers.
2. The format of the athletes' training program was bound by the decisions of the Head Coach, and no special procedures were followed due to the conduct of this study.

3. The observation period was from January 12, 1981 to March 15, 1981, and measurements were made at regular intervals.
4. The scope of this study was delimited to tests of standing height, body weight, skinfold thickness, resting heart rate, resting blood pressure, hemoglobin, and hematocrit. A stress index, a psychological inventory, and a sociological scale completed the battery of tests.
5. The subjects were chosen because of their demonstrated ability to maintain a high quantity of training over an extended period of time.

Limitations

1. It was assumed that the time for the study was sufficient to indicate any patterns of responses.
2. The exploratory nature of the study was accepted as being sufficient to indicate directions for future, more detailed studies of the training parameters of age-group swimmers.
3. This study was limited to the case study approach. Single subjects produced characteristic responses, and the specificity of individual adaptations enabled the study to indicate any functional relationships.

Definitions

Blood Pressure was defined as the driving force that moves blood through the circulatory system. Systolic pressure (the higher pressure) is reached when blood is ejected into the arteries; diastolic pressure (the lower pressure) is reached when the blood drains from the arteries (Fox, 1979).

Body Weight was measured with the athletes in their swim suits, to the nearest 0.1 kg.

Heart Rate was the number of times the heart beats per minute

(Fox, 1979).

Hematocrit (Hct) was defined as the relative amount of plasma and corpuscles in blood (Åstrand & Rodahl, 1977).

Hemoglobin (Hb) was defined as a complex compound found in red blood cells that contains iron (heme) and protein (globin), and is capable of combining with oxygen (Fox, 1979)

Mean Corpuscular Hemoglobin Concentration (M.C.H.C.) was the relation between hemoglobin saturation and the cell volume (hematocrit) (Britton, 1969).

Performance was defined as the times achieved in the actual competitions that were held during the study period.

Resting Heart Rate was defined as the pre-exercise heart rates, measured during the observation period prior to the daily training sessions.

Skinfold Thickness was defined as the thickness of a pinch of skin and subcutaneous fat from which total body fat may be estimated (Fox, 1979).

Standing Height was measured in bare feet, to the nearest 0.5 cm.

Training referred to a program of exercise designed to improve the specific skills and energy systems of the athlete for various swimming events. This involved physiological, psychological, and biomechanical preparations that were directed towards realizing predetermined performance goals.

Chapter II

REVIEW OF LITERATURE

Athletic contests are won on the day of competition after hours and days of strenuous and intensive practice (Cratty, 1973). Due to the voluminous amounts of training for modern competitive athletics, the effects of the stress of physical exercise have become more pronounced than in the past (Carlile, 1963).

Current training methods, particularly in swimming, involve young children in long, very strenuous training sessions over periods of several years. Since training often commences in the early pre-pubertal years, there is a definite need for longitudinal data to be collected to accurately assess the effects of training (Cunningham & Eynon, 1975). Åstrand and Rodahl (1977) stated that such studies are rare, and longitudinal studies must be designed in which the same individual is followed for both short and long periods of time.

There is often a very thin line between training and straining, and the astute coach must be aware of oncoming exhaustion so that he or she can act on the warning signs before the athlete is driven into a state from which it may take a long time to recover (Carlile, 1963). Cratty (1973) stated that many coaches ignore, or are unaware of, the individual differences among their athletes whose physiological and psychological characteristics are unique, as are their varying abilities to handle stress. Therefore, a coach must know as much as possible about each individual athlete and how he or she responds to training (Tutko & Richards, 1971).

Stress consists of the bodily changes produced by the physiological or psychological conditions that tend to upset one's homeostatic balance (Morehouse & Miller, 1976). Physical training exposes an organism to a

training load or work stress of sufficient intensity, duration, and frequency to produce a noticeable or measureable training effect. It is necessary to present a stress which is greater than the one regularly encountered so that an overload is imposed that elicits some catabolic processes at the cellular level. The subsequent anabolic responses cause an increase in the molecules that are mobilized, or broken down during the exposure to the training load. This training load is related to the immediate level of an athlete's fitness, and its intensity must increase over the course of the training period as the organism adapts to the stress thresholds. In athletic training, therefore, the greater the intensity the better, but only up to a certain limit, and the exact magnitude of the load which will produce an optimal training effect will vary from one individual to another, and also with age (Åstrand & Rodahl, 1977).

Coaching sports is more than conditioning individual athletes or teaching isolated skills (Cratty, 1973). Stress management may be considered as one of the coach's primary responsibilities. Although human behaviour is a particularly difficult field, man is within the range of scientific analysis (Skinner, 1972), and tests or monitoring procedures that enable the coach to detect and measure the degree of strain in an individual are necessary (Carlile, 1963). Talbot (1969) stated that there are such tests, but many of them require apparatus that are not available to most coaches, and the interpretation of the results is difficult if the coach does not have a sound medical background. He further stated that the real worth of a test is in its practical application in bringing a greater understanding to swimming coaches, and any test that fulfills that requirement must improve the sport.

Long term training causes adaptations in athletes. Monitoring the effects of training may indicate the degree of exercise stress, and

thereby help the coach to more fully understand the implications of his or her programme.

To date, there are only a few studies of age-group swimmers which monitored changes in certain variables over a competitive period (Andrew, Becklake, Guleria, & Bates, 1972; Bagnall & Kellett, 1977; Newble & Homan, 1978; Stransky, Mickelson, van Fleet, & Davis, 1979).

Young males and females respond physiologically to physical training in the same way, although most males develop a higher working capacity than most females (Morehouse & Miller, 1976). Therefore, training programmes and their specific stress effects can and should be monitored on a regular basis throughout a period of training of age-group swimmers, so that exercise prescriptions can be made more specific, and the coach can watch for the warning signs of chronic fatigue.

Body Weight and Skinfold Measurements

Anatomical changes occur in individuals participating in vigourous physical activity (Dempsey, 1964). These changes in body size depend upon the type, duration, and intensity of the program, the age of the athlete, and the athlete's anthropometric profile at the start (Malina, 1978).

Morehouse and Miller (1976) stated that various types of competitive sports require different proportions of fat to muscle for maximum performance. A minimum amount is required by those athletes who must move their body weight in a highly economical fashion, and for whom any added weight taxes strength and endurance. Distance runners, high jumpers, and gymnasts typify such athletes. However, distance swimmers need a certain amount of fat distributed near the skin surface to diminish the heat loss to the water.

Body weight is a common characteristic used to describe an athlete, but percent of fat is what should concern physicians and coaches (Moore, 1980).

Fat, water, and muscle all vary as a percentage of total body weight, and performance can be adversely affected by excess fat weight.

Some studies indicated that body density changes after physical training programs of various lengths were marginal or nonexistant (Cook & Brynteson, 1973; Katch, Michael, & Jones, 1969; Smith & Stransky, 1976). Other studies have recorded significant changes in percent of fat and skinfold measurements (Dempsey, 1964; Glick & Kaufmann, 1976; Milesis, Pollock, Bah, Ayers, Ward & Linnerud, 1976; Pollock, Dimmick, Miller, Kendrick, & Linnerud, 1975; Stransky, Mickelson, van Fleet, & Davis, 1979; Thompson, 1959; Wade, 1976; Zwiren, Skinner, & Buskirk, 1973).

Thompson (1959) demonstrated the practical use of skinfold measurements to determine changes in body composition associated with conditioning and training. However, such changes are related to the initial skinfold thickness (Dempsey, 1964; Glick & Kaufmann, 1976).

Equations that predict alterations in body compositions based on girth measurements and skinfold thicknesses have been evaluated (Wilmore, Girandola, & Moody, 1970; Zwiren, Skinner, & Buskirk, 1973). These studies suggested that using prediction equations to estimate actual changes in body composition parameters after physical training programmes is basically unsound when used for research purposes.

Since the calculation of percent body fat can be inaccurate due to rounding errors, measurement of the changes in skinfold measurement alone may be a good indication of anthropometrical changes due to training.

The literature supports Morehouse and Miller (1976), who stated that during severe training, the normal amount of fat is reduced to a minimum. A continued loss of weight below an athlete's normal level is a sign of overtraining (Morehouse & Miller), or chronic fatigue resulting from a

failing adaptation to the stress of training (Carlile, 1962). Although skinfold measurements are considered to be inaccurate as a research tool, they are considered to have a practical value in the monitoring of body composition changes associated with training. Used in concert with body weight measurements, they may help the coach to better monitor his/her athlete's responses to the training programme.

Hematological Considerations

It is generally recognized that the capacity to transport oxygen to the working muscle cells is of primary importance to an individual's ability to perform muscular work (Åstrand & Rodahl, 1977; Hermansen, 1973). The main method of transporting oxygen in the blood is via the hemoglobin in the red blood cells. Hemoglobin carries about 98% of the available oxygen.

The hemoglobin levels of athletes can vary during training (Carlile, 1963; Counsilman, 1968; Puhl & Runyan, 1980; Rompotti, 1969; Rushall & Busch, 1980; Talbot, 1969). Since the total amount of circulating hemoglobin is well correlated with maximum oxygen uptake (Kjellberg, Rudhe, & Sjostrand, 1949) and physical work capacity (Ekblom, Goldbarg, & Gullbring, 1972), it is important to take regular hemoglobin tests to assess an athlete's response to the training load (Talbot, 1969). Clement, Asmundson, and Medhurst (1977) stated that the determination of the hemoglobin concentration in blood is a common and routine procedure, the importance of which is that it is a preliminary sign of anemia. Studies of athletes in hard training have shown that decreases of up to 20% in blood hemoglobin have occurred, and such reduced levels have invariably been accompanied by poor performance (Carlile, 1963).

Some studies showed no significant changes in the hemoglobin and

hematocrit values after a period of training (Akgun, Tartaroglu, Durusoy, & Kocaturk, 1974; Weswig & Winkler, 1974; Wirth, Lohman, Avallone, Shire, & Boileau, 1978). Oscai, Williams, and Hertig (1968) found depressed levels of hemoglobin and hematocrit in 14 men who had trained for 16 weeks. However, Puhl and Runyan (1980) suggested that aerobic training in young women may be accompanied by initial decreases in hemoglobin and hematocrit levels which are transitory in nature. All values in their study had returned to pre-training levels by the end of a nine week programme.

Rushall and Busch (1980) measured the hemoglobin and hematocrit levels of nine male swimmers. During the hard training phase, hemoglobin values decreased, and then subsequently increased during a period of reduced training intensity. Hematocrit values followed similar trends, but they were less evident. The patterns of the hematological responses to a period of hard training followed by a period of easier training were unique for each athlete.

Hematological values vary considerably among individuals (Hermansen, 1973). Nutrition Canada (1975) stated that the mean Canadian population values for hemoglobin are 15.5 gm% and 13.6 gm%, and hematocrit ranges are 40-54% and 35-47% for men and women respectively. Britton (1969) said that the range for mean corpuscular hemoglobin concentration is from 32% to 38%.

Hematological values range within certain limits. The coach can use these ranges as guidelines in the assessment of his or her athlete's response to training. Values that approach or exceed the extremes may indicate a high level of training stress.

The literature reinforces the concept of conducting hematological measurements on athletes who are undergoing hard training. Variations in

hemoglobin levels appear to be a good reflection of a reaction to exercise stress. More research is necessary on the implications of hematocrit ratios, as the current literature on humans is scarce.

Cardiovascular Considerations

Intensifying the training in young subjects ultimately leads to dimensional changes in the cardiovascular system (Carlsten & Grimby, 1966), and the reduction of an individual's resting heart rate as a result of regular exercise training has been well documented (Barnard, 1975; Clausen, 1977; Johnson, 1975; Milesis, Pollock, Bah, Ayers, Ward & Linnerud, 1976; Pollock, Dimmick, Miller, Kendrick, & Linnerud, 1975; Rowell, 1974; de Vries, 1968).

Blood pressure measurements have also been conducted. Edington and Edgerton (1976) stated that training alters blood pressure, but the direction of the change is dependent on initial blood pressure levels prior to training. A normal (or below normal) resting blood pressure prior to training tends to increase with training or remain constant. Carlile (1963) observed increases in the resting systolic pressures of elite swimmers in hard training, and he suggested that they were possibly an indication of the increased force of each heart beat. Reductions in blood pressure have been documented (Choquette & Ferguson, 1973; Milesis et al, 1976), and Michael and Gallon (1960) recorded decreased resting systolic blood pressures over 16 weeks of training with a male varsity basketball team. Other studies (Johnson, 1975; Pollock et al, 1975) have shown no significant changes in resting blood pressure due to athletic training, and Choquette and Ferguson (1973) stated that most studies of the blood pressures of young subjects during training periods have shown small and insignificant changes.

Symptoms of chronic fatigue include an elevated resting pulse rate and a lowered blood pressure, which is reflected primarily by a progressive fall of the systolic pressure (Morehouse & Miller, 1976). Schneider (1920) initiated tests of the changes in resting heart rates and blood pressures from the supine to the standing positions. The objectives of this testing format were to determine the presence of a general physical fatigue, rather than any functional abnormalities of the heart. Brown and Kenyon (1969) stated that this test is now considered to be a very useful tool to identify those individuals whose cardiovascular systems reflect general fatigue.

Postural tests are based on the premise that only small increases in the heart rate and blood pressure should occur upon assuming the standing position. Any undue increases in heart rate and a fall in blood pressure are considered to indicate poor vasomotor stability (Morehouse & Miller, 1976; Shephard, 1972).

Psychological Considerations

Behind all the hard work involved in becoming a champion swimmer, there is a considerable amount of psychological conditioning which contributes to the champion's success (Talbot, 1969). Carlile (1963) indicated that reliable information on the personalities of swimmers can be of practical value to the coach by helping him or her understand the athlete, and indicating how that individual could be handled. If a coach can learn what motivates an athlete at a certain time and in a certain environment, he can elicit better performance (Cratty, 1973).

Psychological problems tend to be individual, and they require special attention (Cratty, 1973; Rushall, 1979a; Tutko & Richards, 1971). Since each athlete is uniquely motivated to compete (Cratty; Tutko & Richards), the coach is responsible for the creation of sporting environments that

satisfy the needs and motivations of each participant (Rushall, 1979a).

Psychological and sociological information in sport will be helpful only to the extent that the coach can interpret the data properly and specifically in his or her own situation (Cratty, 1973; Rushall, 1979b). Rushall (1979b) criticized those psychological tests that deal with constructs such as "determination", "coachability", and "reactivity" because they are purely descriptive and vague. He felt that they are not useful for predicting specific situational behaviours. However, such personality tests have been used extensively (Behrman, 1967; Cratty, 1973; Maglischo, 1974; Newman, 1968; O'Connor & Webb, 1976; Young & Ismail, 1976). In 1970, Rushall found no relationship between personality profiles and categories of swimming performance, and he concluded in 1978 that the use of personality inventories for determining behavioural inferences and sport classifications has proven to be unsatisfactory.

That internationally famous swimming coaches have used personality tests has been documented (Carlile, 1963; Counsilman, 1968; Talbot, 1969). Rushall (1973) offered an alternative. He developed specific inventories which assesses the behaviours of individuals performing in different environments. The Psychological Inventories for Competitive Swimmers has been used to determine key motivational items of certain swimmers (Rushall, Jamieson & Talbot, 1977; Rushall & Fry, 1980).

Behavioural control procedures for coaching can be established (Harari, 1969; McKenzie & Rushall, 1974; Rushall & Pettinger, 1969).

Psychological staleness is marked by a loss of interest in training and even in competition (Counsilman, 1968; Morehouse & Miller, 1976). Cratty (1973) stated that athletes differ about what constitutes a stressful event.

Rushall (1975) has devised a specific check-list called a Daily Analysis of Life Demands for Athletes, which locates the source of stress in a swimmer's life. It is also used to indicate symptoms of acute debilitating fatigue. Rushall (1980) stated that it is very sensitive to daily events in a swimmer's life, and it provides functional information about the athlete's ongoing perceptions and attitudes.

The interactions of the behaviours among athletes constitute an important dimension of the total athletic environment (Cratty, 1973). Cratty further stated that within sports groups, the psychological closeness that members feel toward one another can vary, so that subgroups of athletes feel closer to each other. Since athletes are aware of the attention of peers, plaudits or censures can be important reinforcers (Cratty, 1973; McKenzie, 1972; McKenzie & Rushall, 1974). Cratty discussed the development of a sociogram that would determine the individual's most-preferred and least-preferred teammates, and he suggested that changes in group dynamics during a season of training may be compared to success rates of individuals.

The possibility of chronic fatigue consuming the athlete may be reduced or eliminated through its early identification by easily administered, coach-implemented tests. The literature indicates that such tests are needed, that they are available, but that they are used infrequently.

Chapter III

METHODS AND PROCEDURES

Research Design

This investigation was based on an intra-subject, case study design. This was due to the individual nature of the subject's possible responses to training. If any such responses were highly similar in some important respects, tentative generalizations concerning the individual and/or the group were offered (Scott, 1959).

Subjects and the Setting

Three male and three female age-group swimmers from the Thunderbolts Swim Club of Thunder Bay, Ontario were the subjects of this investigation. They were the club's top performers.

The subjects conducted their training programme under the direction of the Head Coach. The normal schedule of eleven practices per week were only interrupted due to travel arrangements prior to away competitions, or to unforeseen illnesses or injuries. The six subjects were fully cognizant of the investigation, and they had co-signed a formal participation consent form with their parents (see Appendix A).

The training intensity was reduced prior to some competitions during the period of this study. This was at the discretion of the Head Coach. No special procedures were followed due to this investigation.

All practices and testing procedures were conducted in the Lakehead University gymnasium and pool complex. Both the swimming pool and the human performance laboratory were available for the use of this study.

Test Descriptions and Procedures

Anthropometrical Measurements

The Height and Weight of each subject were measured biweekly on a medical weight scale (Health-o-meter; Model No. 408 DPL) that had a height scale attached.

The subject stood on the scale in his or her swim suit without footwear. Body weight was recorded to the nearest 0.1 kg. Then, the subject ensured that his or her feet were together, and that the body was stretched upward to the fullest extent, with the shoulders relaxed and the arms stretched downward. Height was recorded to the nearest 0.5 cm.

Both the height and weight were used as data.

Skinfold Measurements were determined biweekly by a Harpenden skinfold caliper (No. 470980), which exerted a constant pressure of 10 gm/mm^2 at varying openings of the jaws. The width of the opening was read from a scale incorporated in the apparatus. The four sites measured were:

1) biceps: measured on the front of the right pendant upper arm over the biceps, at a level midway between the tip of the acromion and the tip of the elbow.
2) triceps: measured on the back of the pendant right arm, at a level midway between the tip of the acromion and the tip of the elbow.
3) subscapular: measured 1 cm below the lower angle of the right scapula. The crease of the skinfold ran at an angle 45^{o} downward from the spine.
4) suprailiac: measured 3 cm above the suprailiac crest, with the skinfold running parallel to the crest.

All measurements were taken on the right side of the standing subject. A fold of skin and subcutaneous tissue was grasped between the tester's thumb and index finger 1 cm above the measurement site (Brozek, 1956;

Keys, 1956), and pinched clean away from the underlying muscle. The crest of the fold followed the appropriate alignment. The calipers were then applied, with the jaws at right angles to the fold, and the spring handles were released fully. The measurement was read to the nearest millimeter, after the full pressure of the caliper jaws had been applied, and the drift of the needle had ceased.

This procedure was repeated twice. If the difference was greater than 1 mm, a third measurement was taken, and a mean of the closest pair was recorded. The four measurements were summed, and the total served as a datum.

Hematological Measurements

Hemoglobin concentrations were determined by the cyanmethemoglobin method as described by Faulkner and King (1970).

The subject placed one hand in a basin of hot water for 2 to 3 minutes in order to stimulate finger blood flow. After drying the hand and disinfecting the finger with alcohol, the tester pricked the pad of flesh at the tip of the finger quickly and deeply enough so that a sufficient amount of blood was produced. A blood lancet was used. The initial drop of blood was removed so that any tissue or fluids did not contaminate the results.

Fresh blood (0.02 ml) was drawn into a glass disposable microsampling pipet. The blood was then added to exactly 5 ml of Drabkin's solution in a test tube, and mixed thoroughly. This solution stood for at least 2 minutes.

The optical density of this solution was measured in a spectrophotometer (Bausch & Lomb, Spectronic 20, serial No. 0816945 D) that had been warmed up for at least 30 minutes. This wave length was set at exactly

540 mu.

The hemoglobin concentration was read from a reference curve. The standard curve was made by plotting the optical density of known concentrations of Drabkin's solution against hemoglobin concentrations (ordinate) in gm% on arithmetic graph paper. Five points were calculated, and they lay on a straight line that passed through the zero point.

The reagents of Drabkin's solution are sodium bicarbonate (1.00 g), potassium cyanide (0.05 g), and potassium ferricyanide (0.29 g) combined with enough distilled water to make a 1000 ml solution (Faulkner & King, 1970). In this study, commercially produced diluent tablets were combined with enough distilled water to make a solution of 250 ml. The proportions were exactly the same. The Drabkin's solution was stored in a brown bottle.

Two blood samples were measured, and the results were averaged. This value was a datum.

Hematocrit values were determined by the method described by Faulkner and King (1970).

After the two samples of blood had been mixed with the Drabkin's solution for Hb measurement, two more blood samples were drawn into heparinized microhematocrit tubes. The coloured end of the capillary tube was sealed with moulding clay. These two tubes were then placed into a microhematocrit centrifuge head (Adams Autocrit Centrifuge, serial no. M11301), with the unsealed end near the hub. When the samples from all subjects had been collected, the head cover was tightened and the centrifuge lid was closed. The centrifuge spun for 5 minutes, at the end of which the packed-cell volume expressed as a percentage of the whole-blood volume was read from the scale on the centrifuge head. The two values were averaged, and this value was a datum.

Mean Corpuscular Hemoglobin Concentration was calculated according to the following formula (Britton, 1969):

$$M.C.H.C. = \frac{Hb \times 100}{Hct}$$

This value was a datum.

Hb, Hct, and M.C.H.C. measurements were made twice weekly, unless the coach asked for more frequent tests during a particular phase of the training.

Cardiovascular Measurements

Resting Heart Rates and Resting Blood Pressures were calculated once per week according to the Schneider (1920) technique. The subject lay down in a quiet room for 5 minutes, after which the heart rate was counted for 20 seconds. When two consecutive 20 second counts were the same, this number was multiplied by 3 and recorded.

Blood pressure in the supine position was then recorded. An indirect ausculatory method was used, and a sphygmomanometer cuff was placed firmly over the left arm. A stethoscope was placed over the brachial artery, and the pressure was rapidly inflated until the blood flow through the artery was occluded. The pressure was released from the cuff until the force developed by the heart during systole was great enough to force blood past the cuff. At this point, a distinct sound was heard, which was recorded as the systolic blood pressure. The pressure in the cuff was lowered further, allowing the sound to increase. When the point was reached where the pressure remaining in the artery at the end of the diastole was still great enough to force the blood by the occluding cuff, another distinct sound change was heard. This was recorded as the diastolic blood pressure.

The subject then stood up for 3 minutes, at the end of which the

aforementioned procedures were repeated.

The systolic and diastolic blood pressures in the supine and standing positions were recorded as data.

Psychological Measurements

Social Structure was assessed by the responses of the subjects to a written test. Each swimmer was given a table in which the names of the group members were listed in a column at the left, with three response items across the top. The subjects were asked to indicate 1) who they would like to work with, 2) who they would not like to work with, and 3) who fell in between these categories. They were instructed not to collaborate with anyone about the task. Prior to the test, they were assured that the information within the checklist would remain confidential between the athlete and investigator.

The total number of positive and negative interactions were recorded as data.

A Stress Index (Daily Analyses of Life Demands for Swimmers, Rushall 1975) was completed by the subjects to assess whether they were stressed. It identified the factors leading to the stressed condition. The quantity and quality of stresses were graphed to indicate individual reaction patterns. This information was accessible to the coach and the swimmers.

Both these tests were completed at the same time. The subjects sat in a lecture room in the Lakehead University gymnasium complex, and they were spaced far enough to prevent collusion. The investigator supervised the tests, which were conducted twice per week.

Psychological Inventories were administered at the beginning and at

the end of the study period. The six subjects completed the Psychological Inventories for Competitive Swimmers (Rushall, 1974). Responses were analyzed to see which question's responses changed over the time between the two tests.

Data Control

1. Anthropometrical measurements were controlled by having the same tester use the same equipment and techniques every time.
2. Hematological measurements were controlled by having the same clinical technician draw the blood each time. In the event that the investigator had to perform the function due to some unforseen absence of the technician, reliability was established at the beginning of the study.
3. Cardiovascular measurements were controlled by having the same tester use the same equipment and techniques every time.
4. Psychological measurements were controlled by having the subjects complete their tests confidentially and in silence, and supervised by the investigator.
5. Diurnal variations were eliminated by conducting the testing procedures at the same time each day. This was between 1615 and 1645 hours, just prior to the afternoon training session.

Decision Criteria

To determine if changes in the physiological parameters had taken place, the following criteria were employed for decision making purposes:

1. If the body weight of an athlete changed by more than 2 kg, then the value was deemed to have changed.
2. If the total of the four skinfold measurements changed by more than 5 mm, then the value was deemed to have changed.

3. If an Hb value varied by more than 0.5 gm%, then the value was deemed to have changed.
4. If an Hct value varied by more than 2%, then the value was deemed to have changed.
5. If the difference in the resting heart rates between the supine and standing position increased by more than 12 beats per minute, then a change was deemed to have occurred (Schneider, 1920).
6. If the difference in the resting blood pressures between the supine and standing positions decreased by more than 10 mmHg, then a change was deemed to have occurred.

Changes in other variables were followed, but decisions were not made on the basis of their variations. The above criteria values were selected, in most cases, purely on the basis of investigator opinions.

Analysis of Data

Graphs were presented to illustrate any trends in the various parameters in each individual over the period of the study. Individual data were presented in tabular form, and they are to be found in the Appendix.

No statistical analyses were intended. Changes had to be visually obvious (Carlile & Carlile, 1961) to be recognized. The number and types of changes were compared between subjects.

Chapter IV

RESULTS

The group of subjects for this study was comprised of three girls (F1, F2, F3) and three boys (M1, M2, M3). The observation period was from January 12, 1981 to March 15, 1981. During this time, there were three phases to the training program.

1. January 12 to 23, 1981 (Phase 1). Each week was comprised of 23,000 m of effort swims. The training pace was 90% to 95% of the athlete's best competitive time for the particular distance that he/she was repeating.

2. January 24 to February 2, 1981 (Phase 2). The workload was reduced considerably, in order to taper for a regional competition.

3. February 3 to March 15, 1981 (Phase 3). Effort swims at 90% to 95% of competitive times were resumed, but the weekly volume of effort sets was reduced to 16,000 m.

Standing Height

The standing heights of the subjects did not change during the period of the study (see Appendix B, Table 1).

Body Weight

The body weights of four subjects (F1, F3, M2, M3) did not vary by more than 2 kg from the beginning of the study. Their values were deemed to have not changed. However, their weights did fluctuate with the 2 kg range, but any variations were individual. No inter-subject patterns were apparent (see Figure 1).

Subject F2 increased steadily throughout the study. The most dramatic increase was during Phases 1 and 2, when her body weight increased 2 kg, a demonstrable change. After this, body weight variations were minimal.

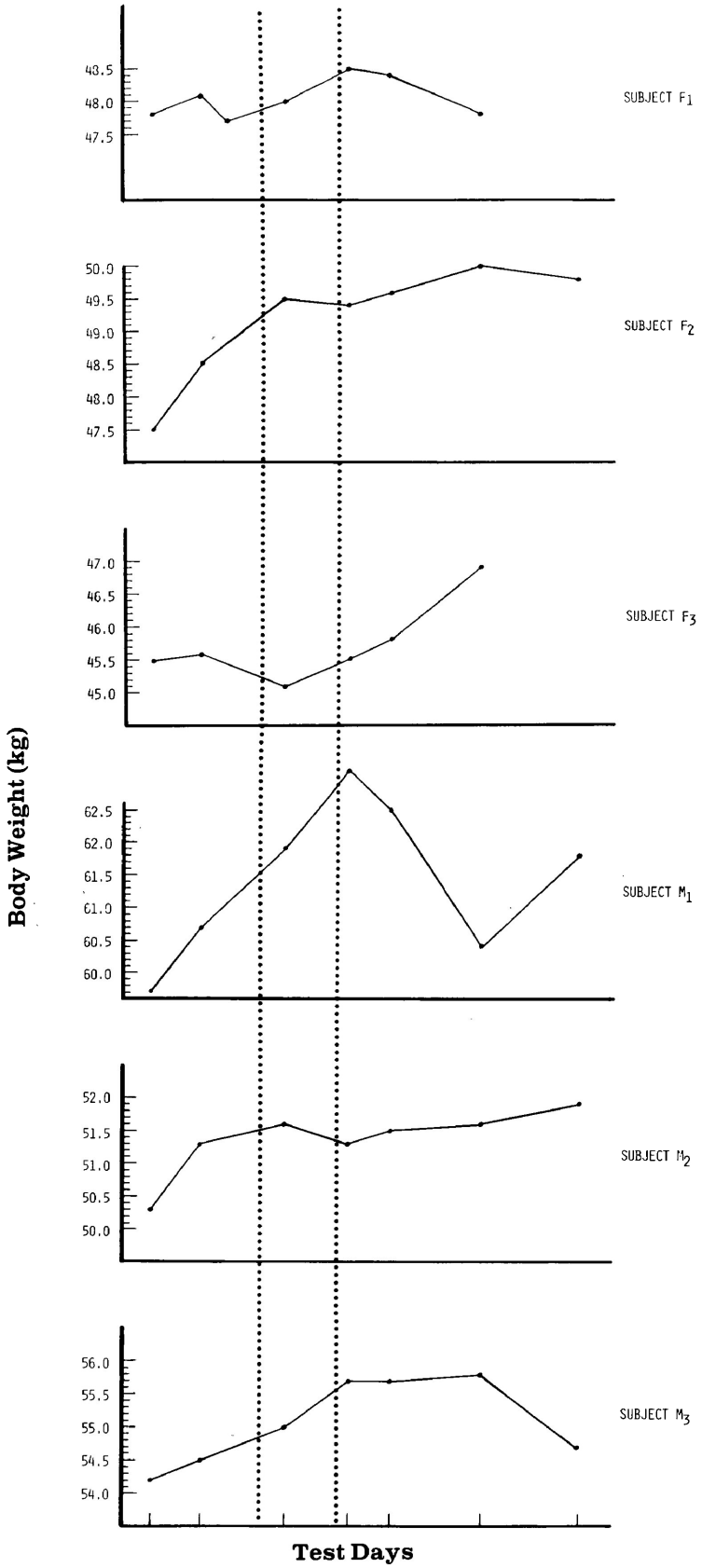

Figure 1. Body weights during the three training phases

Her weight changed at the beginning of the study, and then levelled off.

M1 had realized a change by the middle of Phase 2, and another change was recorded at the beginning of Phase 3. During this time, his weight increased from 59.7 to 63.1 kg, a gain of 3.4 kg. However, it decreased 2.7 kg by the third measurement in Phase 3. This negative change was followed by a modest positive gain of 1.4 kg by the subsequent and final measurement of the investigation.

Skinfold Measurements

The total of the four skinfold measurements did not vary more than 5 mm for five of the six subjects (F1, F3, M1, M2, M3). Therefore, their values were deemed to have not changed (see Figures 2A and 2B).

By the beginning of Phase 3, F2 had increased her skinfold total by 5 mm. By the fifth measurement, the absolute value had risen to 29.4 mm. There was a change of 7.2 mm from the initial skinfold total. The final measurement was a modest reduction of 1.3 mm, to a total of 28.1 mm.

Resting Heart Rates

The decision criterion for this parameter stipulated that if the difference between the supine and the standing positions increased by more than 12 beats per minute, then a change was deemed to have occurred. There were more changes in the heart rate measurements than in the three previous parameters. The values for all the subjects fluctuated, but the magnitude of intra-subject variations were individual, as were most inter-subject patterns of heart rate responses (see Figure 3).

F1 recorded two changes, in Phase 2 and in the initial measurement of Phase 3. All other values were within 12 beats. M1 also realized two changes, both of which were in the initial part of Phase 3. F2 and

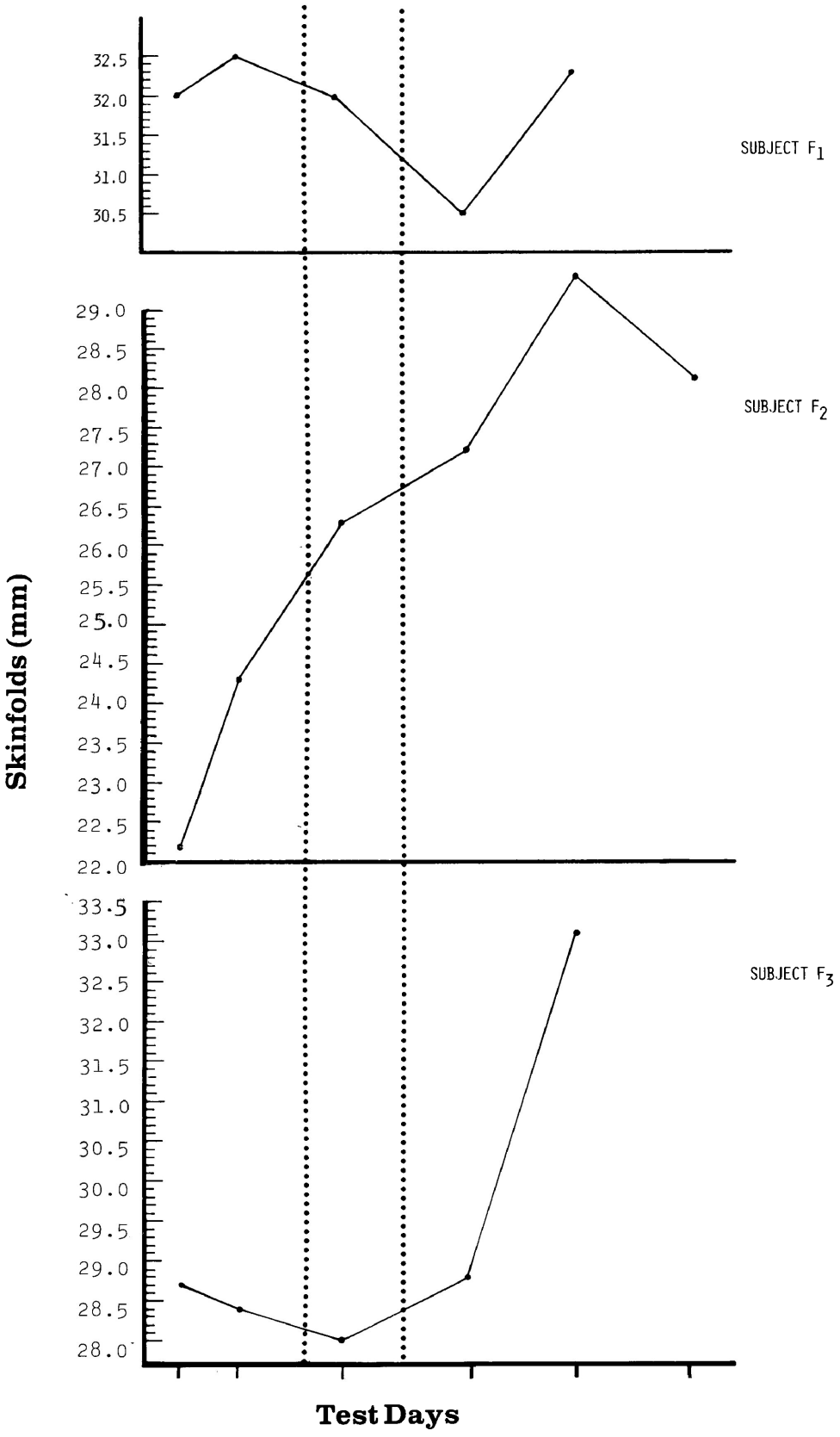

Figure 2A. Skinfold measurements of the three female subjects during the three training phases.

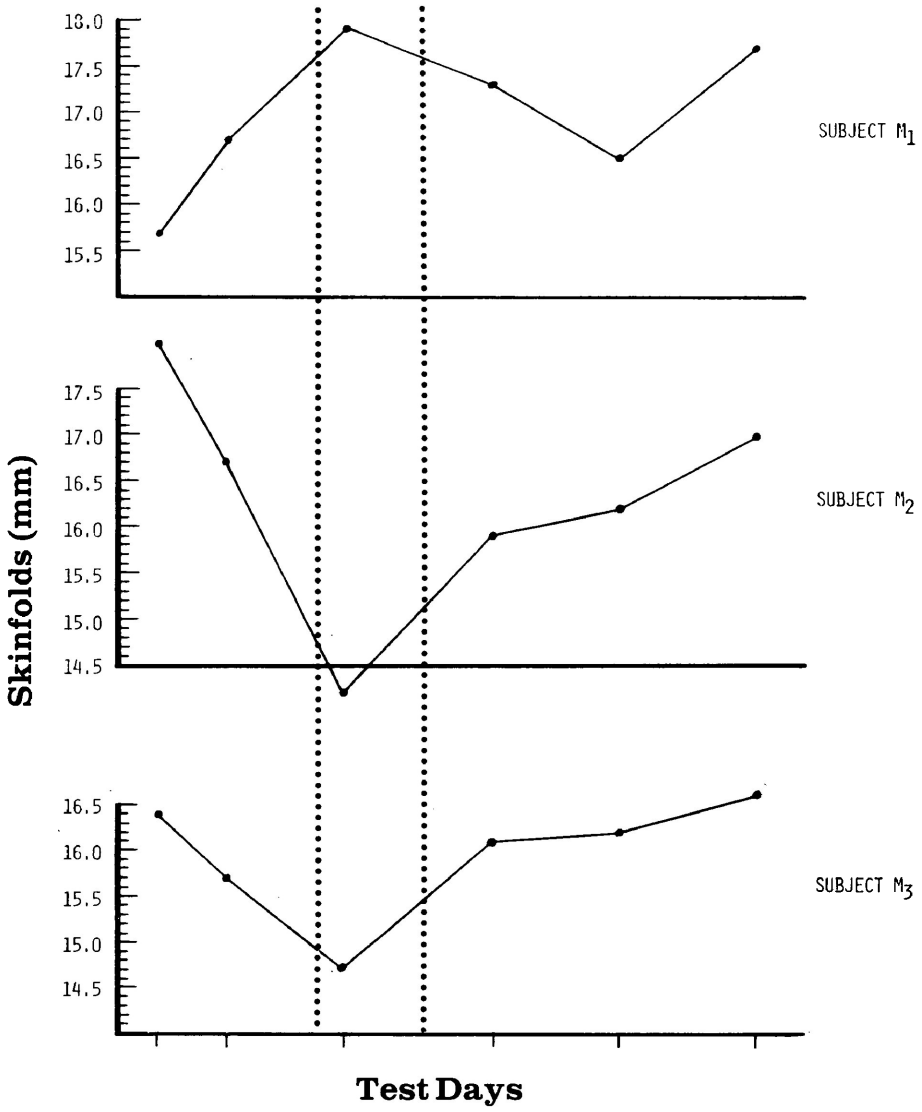

Figure 2B. Skinfold measurements of the three male subjects during the three training phases.

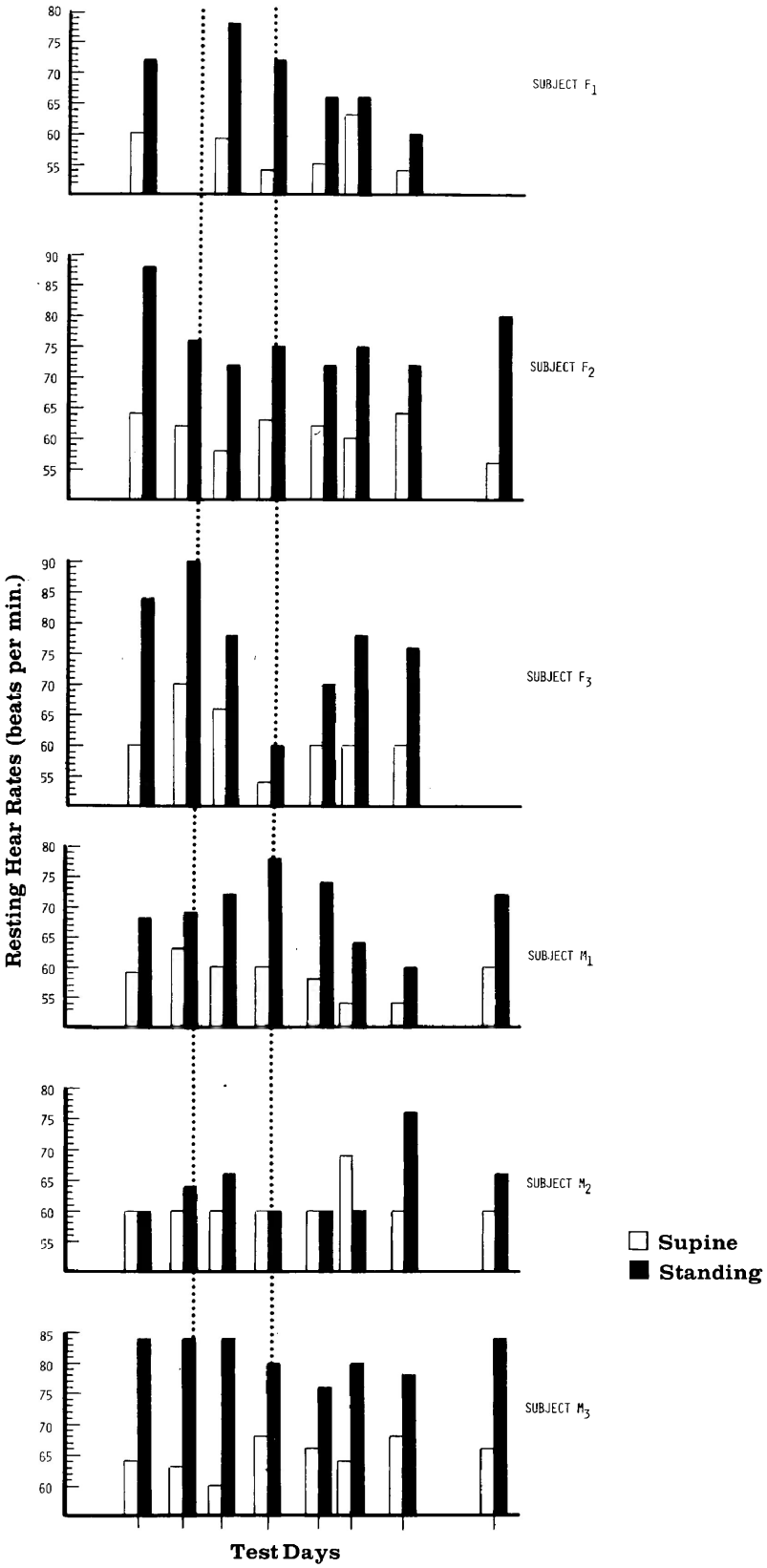

Figure 3. Resting heart rates during the three training phases.

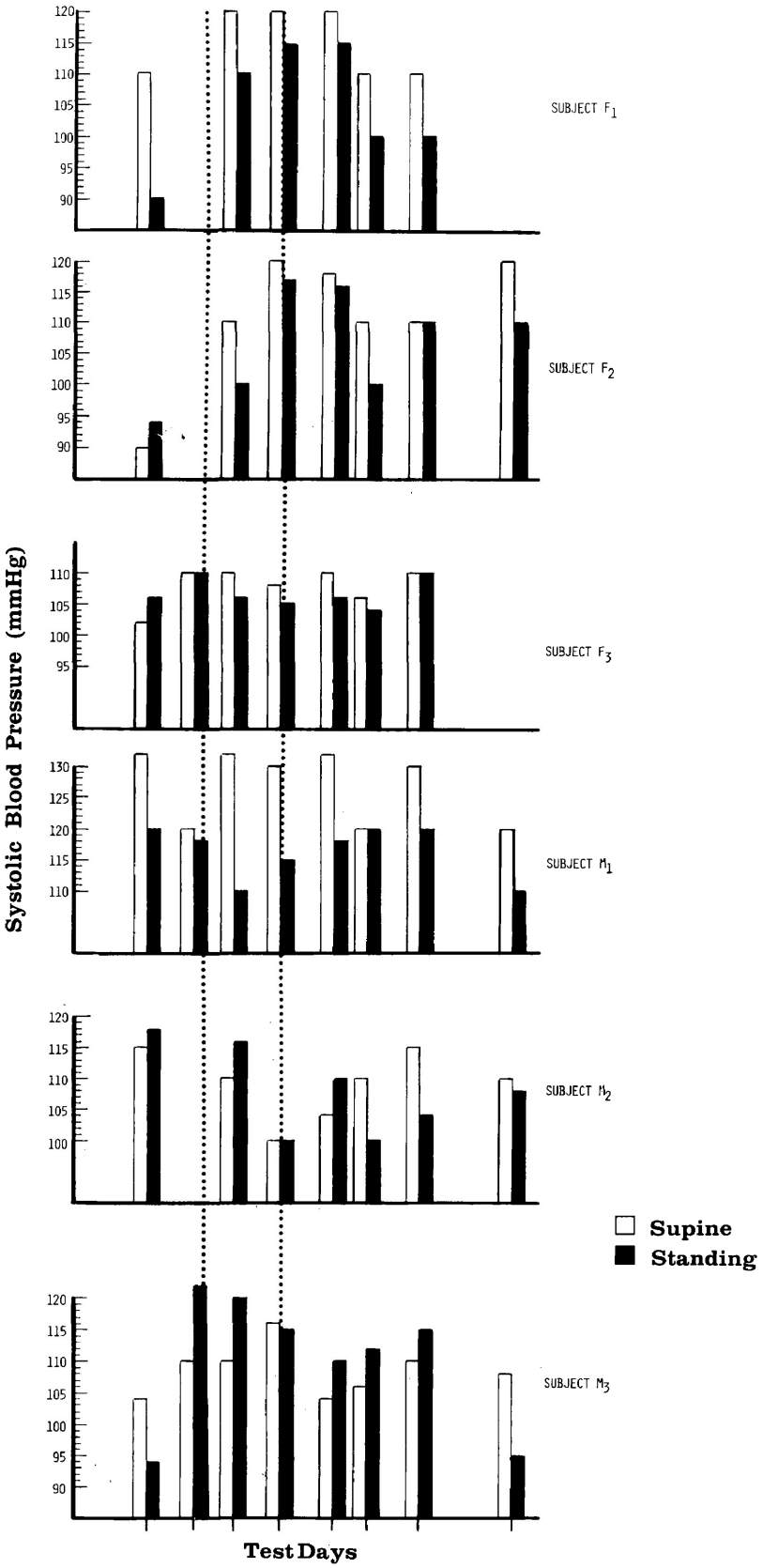

Figure 4. Systolic blood pressures during the three training phases.

M3 demonstrated similar, but not parallel responses. Changes for both occurred during the first three measurements. The next two recordings were steady, the sixth measurement for both had changed, the seventh demonstrated no change, and the eighth and final measurement changed for both. F2 and M3 had similar patterns of heart rate responses, but the magnitude of the changes were individual.

F3 recorded changes on her initial two and final two measurements, whereas M2 only demonstrated a change on the seventh recording. All other values for M2 were within 6 beats of each other, except for his sixth measurement, which registered a negative variation of 9.

Resting Blood Pressures

The decision criterion for the systolic and diastolic blood pressures stated that if the differences between the supine and standing positions for each measurement decreased by more than 10 mmHg, then a change would have occurred.

Systolic pressures. The intra-subject variations were unique to the individuals, and no particular patterns were discernable over the three phases. Inter-subject comparisons revealed no commonalities; responses were individual (see Figure 4).

Two subjects (F2, F3) demonstrated no changes throughout the investigation. Two subjects had one change each; F1 had a drop of 20 mmHg during the first test, whereas M2 had a drop of 11 mmHg during the seventh test. M3 recorded changes of 12 mmHg and 13 mmHg on the second and last measurements respectively, but M1 had changes on the first (12 mmHg), third (22 mmHg), fourth (15 mmHg), and fifth (14 mmHg) test days. No consistent pattern was visually obvious from these data.

Diastolic pressures. As with the systolic blood pressures, the

intra-subject variations were unique to the individuals, and no particular patterns were discernable over the three phases. Inter-subject comparisons revealed no commonalities; responses were individual (see Figure 5).

No subjects produced any changes as defined by the decision criterion. However, some subjects occassionally realized large positive variations after assuming the standing position. On the third test, F1, F2, and F3 recorded differences over 20 mmHg; this was during the taper phase. M1, M2, and M3 had variations that frequently exceeded 20 mmHg. These differences followed no particular pattern.

Hemoglobin

No discernable patterns were evident during the three phases, both on an intra-subject basis, as well as after an inter-subject comparison. During the taper phase, there was no apparent effect across a four day period. Responses of this parameter were particularly individual (see Figure 6).

During a testing week, there were variations from one test day to the next that were in excess of 0.5 gm%. Most variations were less than the critical value. However, with the variations and actual changes, there emerged a discernable pattern whereby the Hb values at the beginning of the week were usually higher than those at the end of the week.

Hematocrit

There were no visually obvious patterns over the period of the study. As with the hemoglobin, the taper period produced no particular responses. Variations were individual. There were variations on a daily basis, and those that exceeded 2% Hct were considered to be appreciable changes (see Figures 7A and 7B).

F1 and F2 did not realize any changes. F3 realized one change of 2.2%, on the third test day of Phase 2. The changes with the male participants

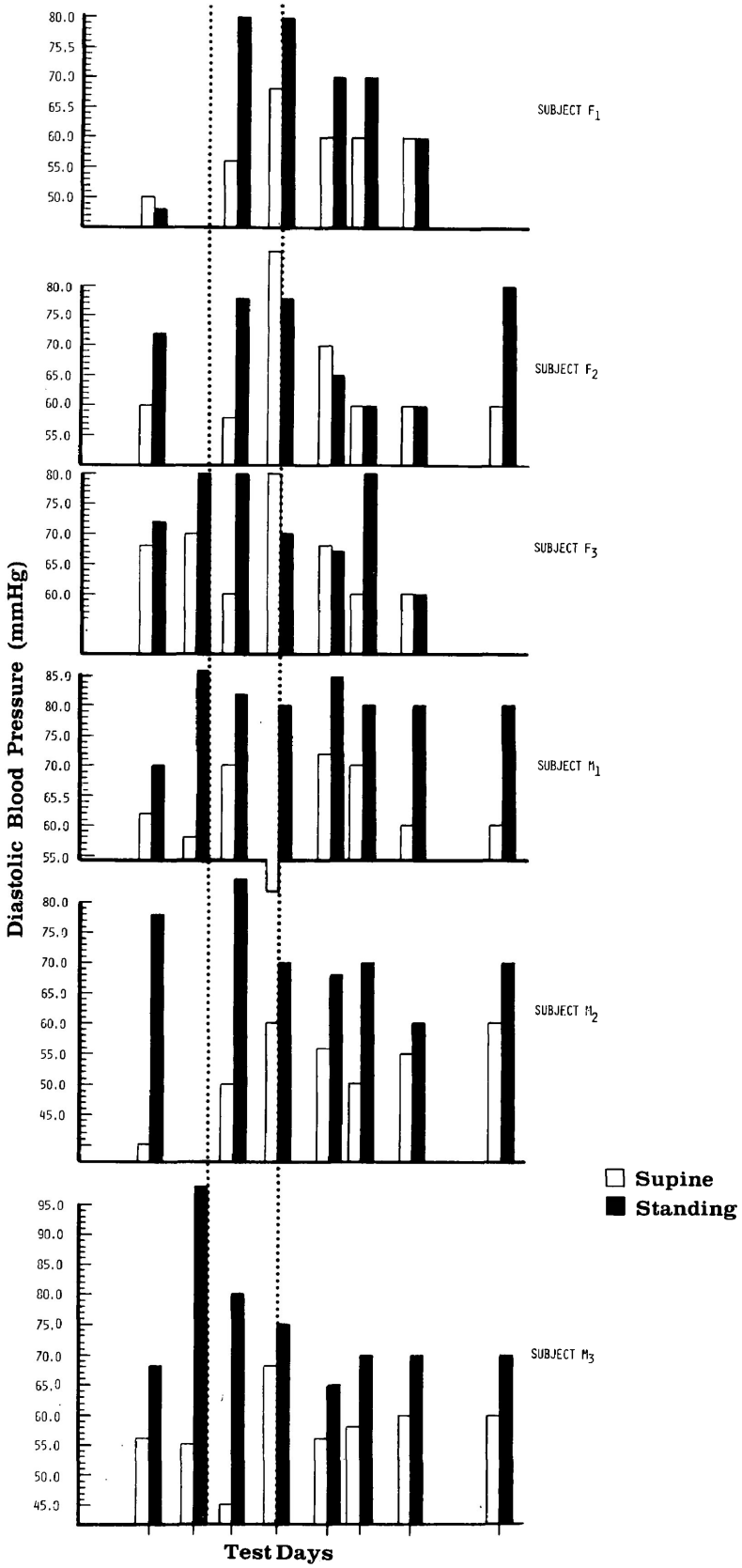

Figure 5. Diastolic blood pressures during the three training phases.

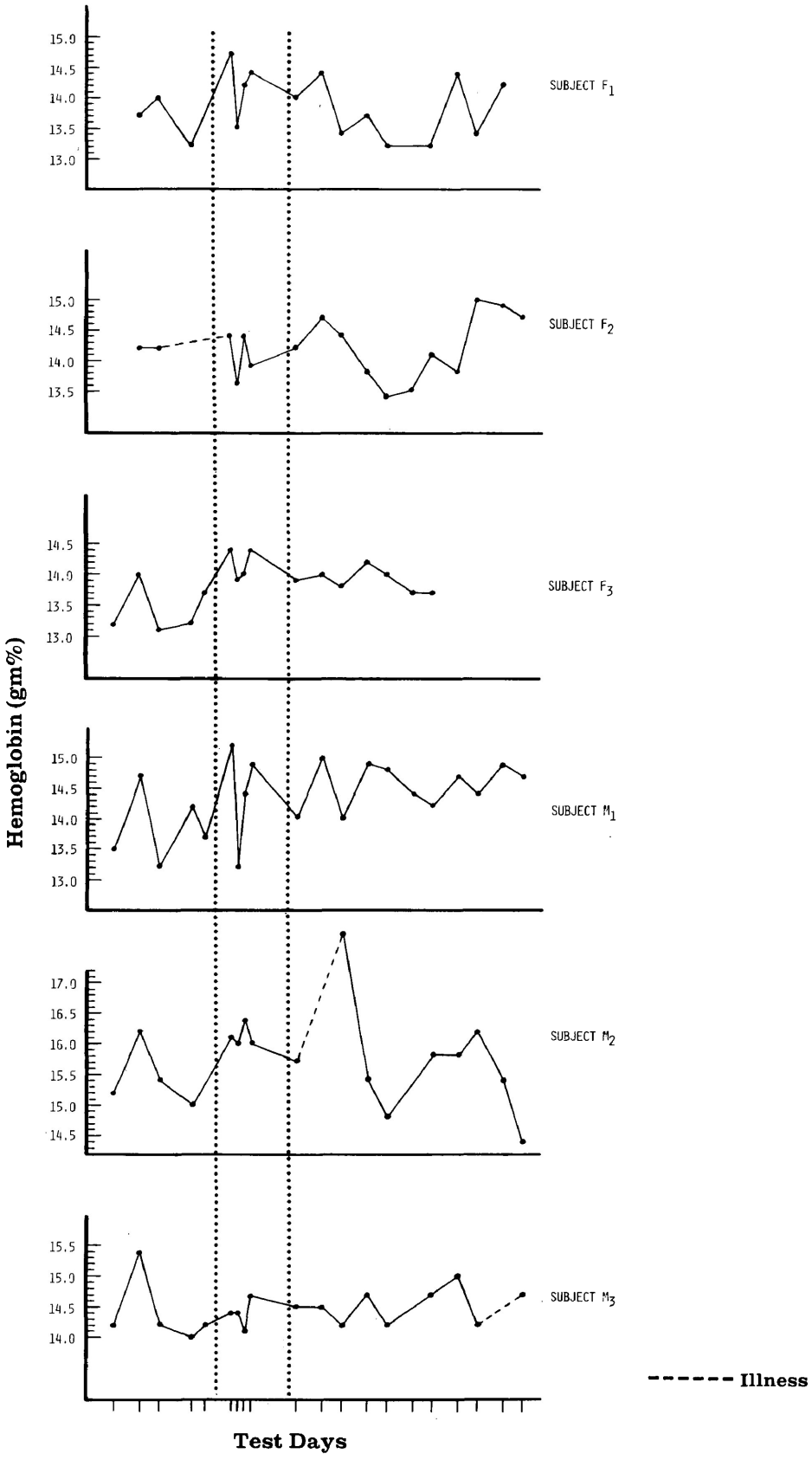

Figure 6. Hemoglobin values during the three training phases.

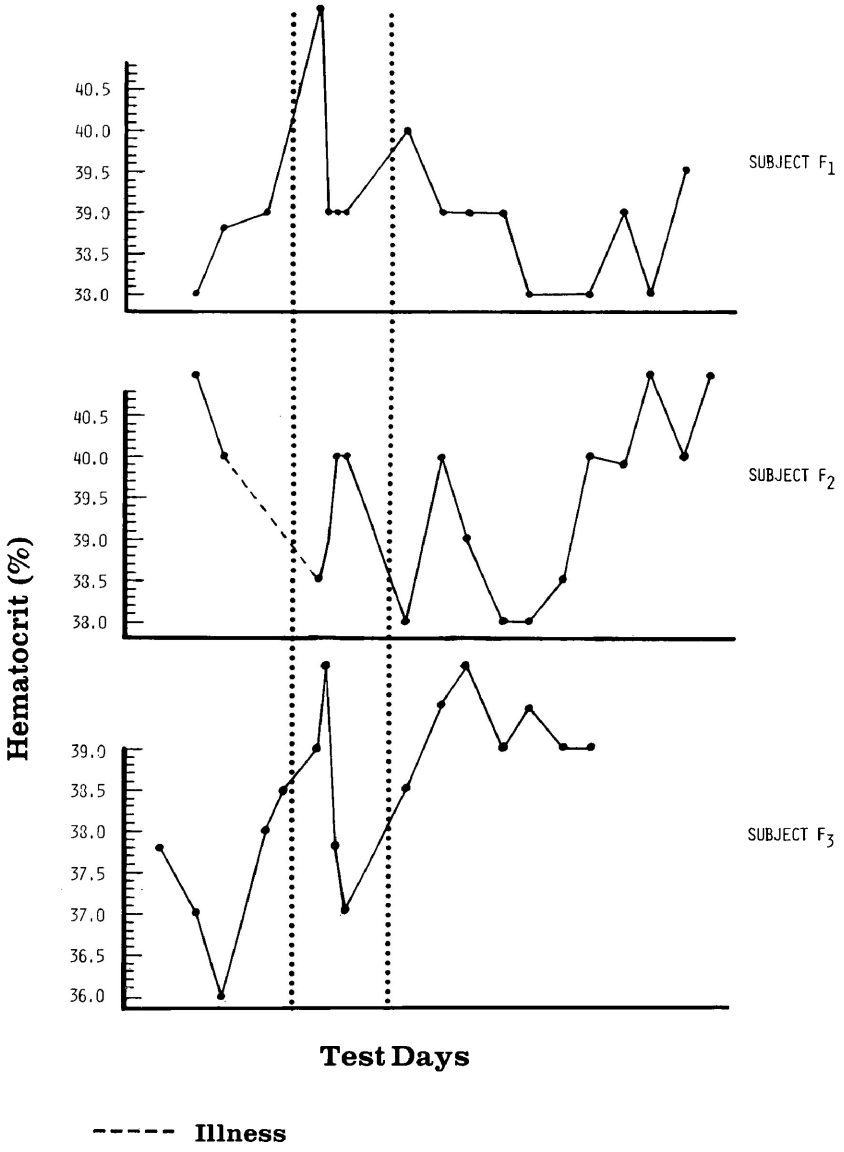

Figure 7A. Hematocrit values of the three female subjects during the three training phases.

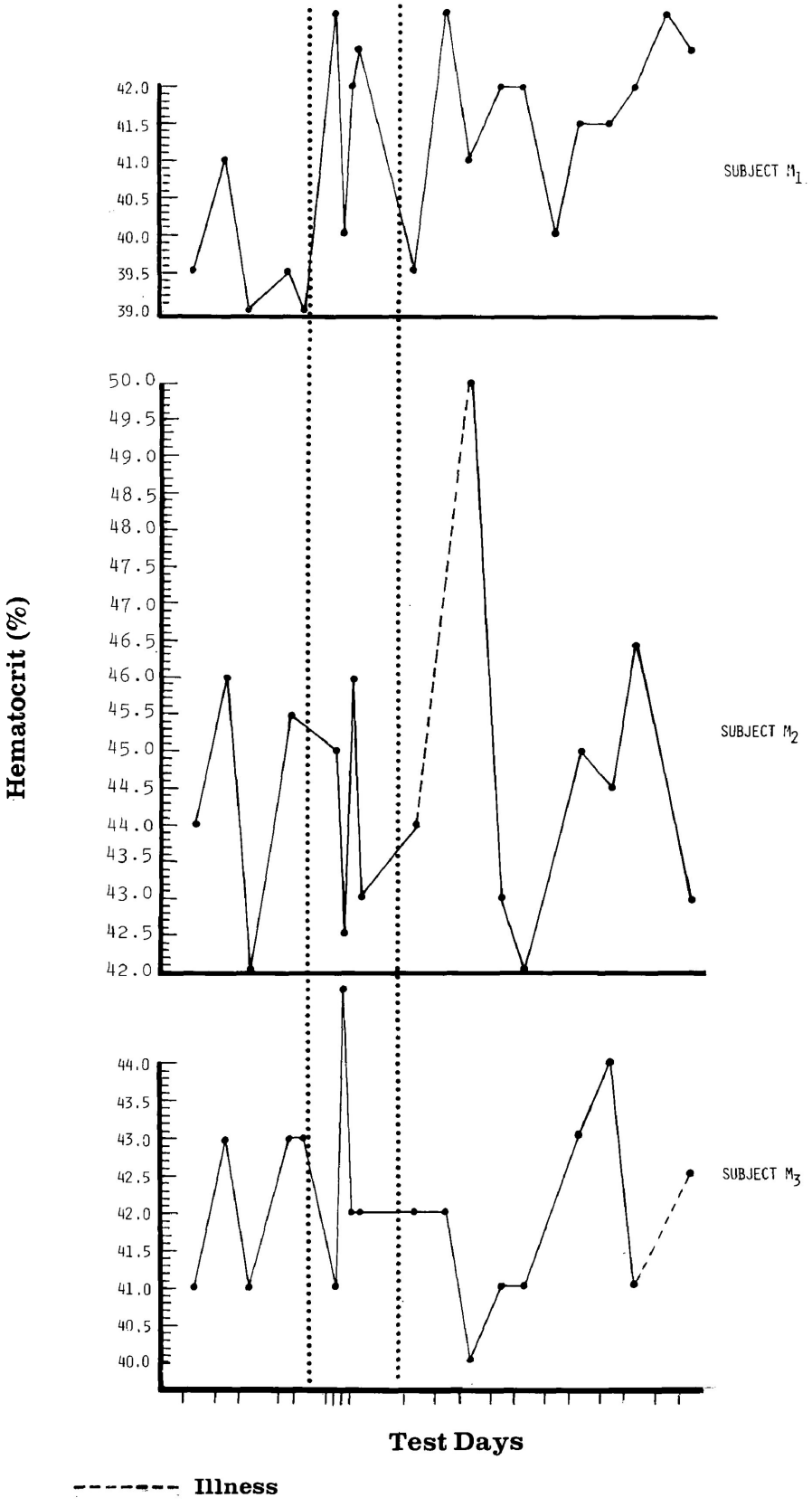

Figure 7B. Hematocrit values of the three male subjects during the three training phases.

were more frequent, and were of a larger magnitude. M1 had four changes, the values of which ranged from 3.0% to 4.0%, M2 had five changes, ranging from 2.5% to 4.0%, but M3 only had two, one of 3.0% and the other of 4.0%. On the twelfth hematological test day, M2 produced an abnormally high Hct value of 50.0%; this measurement had been taken shortly after he had vomited. This result possibly reflects dehydration.

The hematocrit values fluctuated widely on an irregular basis. No common patterns with the Hb values were apparent.

Mean Corpuscular Hemoglobin Concentration

Since M.C.H.C. is a function of Hb and Hct values, it is not surprising that there was no discernable pattern with this parameter over the three phases. Variations occurred on a daily basis; the magnitude of intra-subject and inter-subject shifts were individual. No visually obvious patterns among Hb, Hct, and M.C.H.C. were apparent (see Figure 8).

Sociological Scale

There were no major inter-subject patterns over the study period. Intra-subject variations appeared to be minimal; the results were reasonably stable across the three phases. There were no drastic fluctuations during the taper phase. The magnitude of the responses were individual (see Figure 9).

Psychological Inventory

The analysis of the behavioral inventory was based on the premise that during the investigation period, behaviors 1) increased, 2) decreased, or 3) were consistent. Five of the six subjects completed the inventory. The intra-subject ratios of increased, decreased, and consistent behaviors were individual. No patterns were obvious.

The specific behavioral items were analyzed to ascertain if any

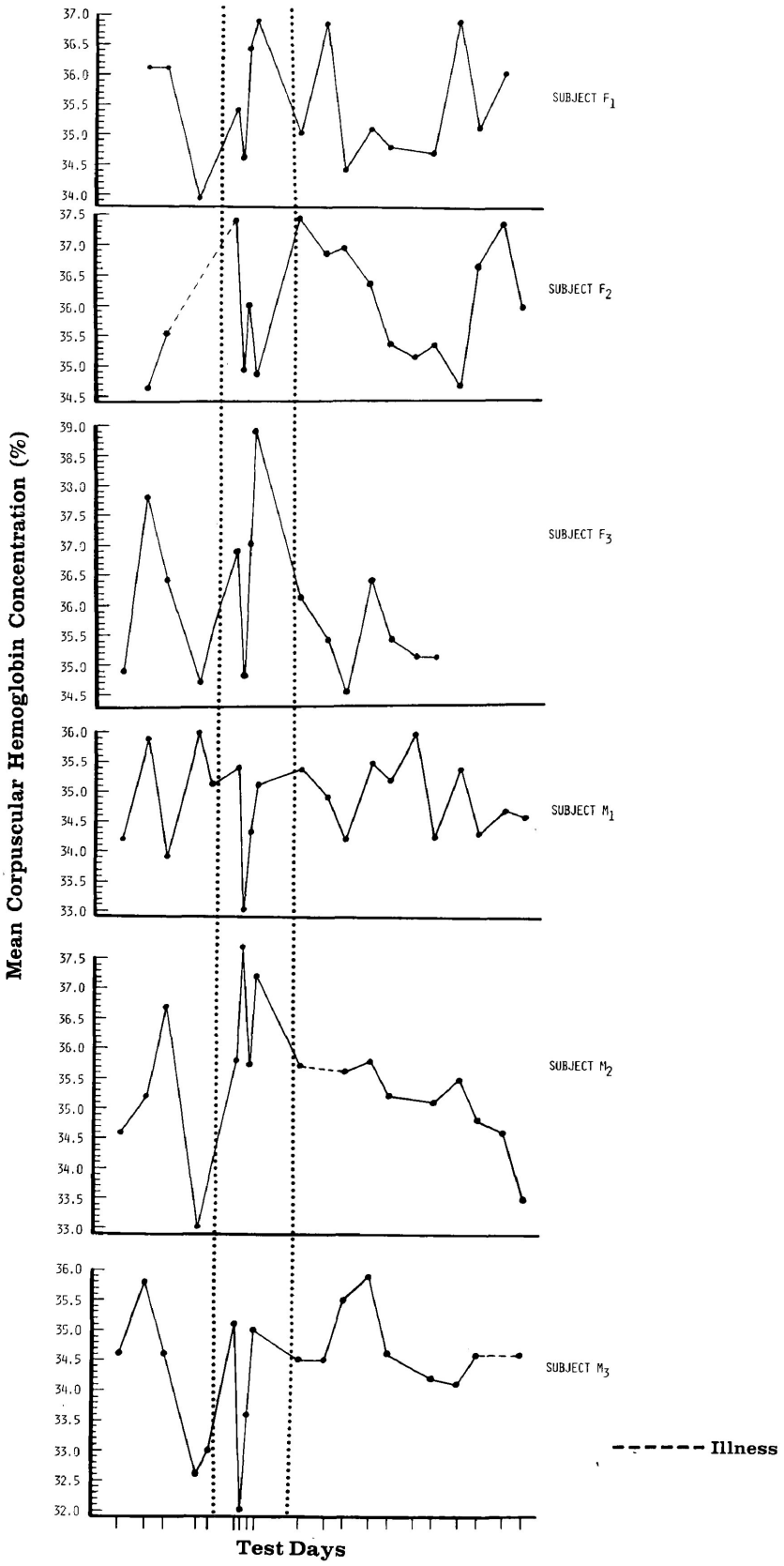

Figure 8. Mean corpuscular hemoglobin content values during the three training phases.

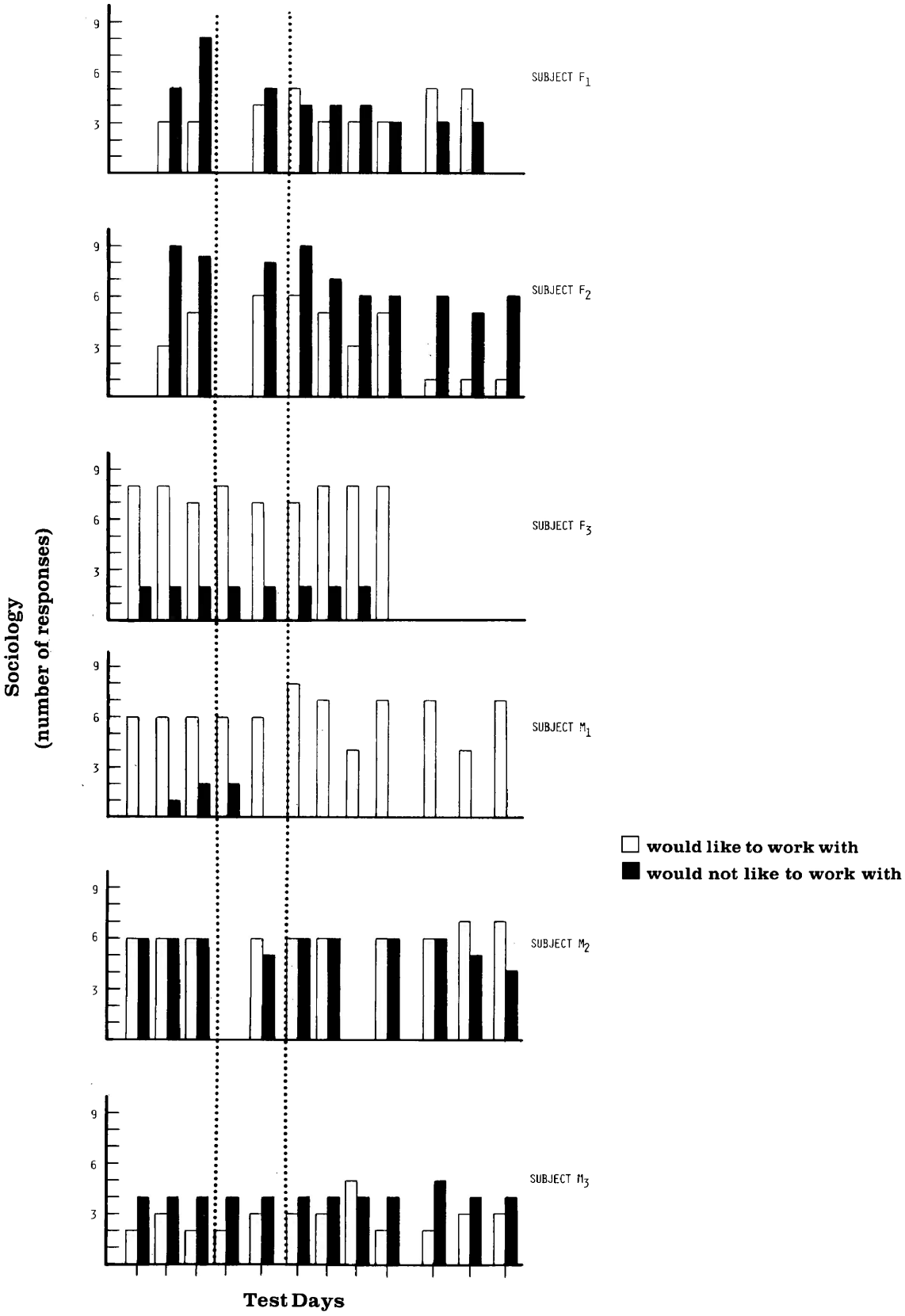

Figure 9. Sociological responses during the three training phases.

responses were 1) common to all participants, 2) common to 4 out of the 5 participants, 3) common to the males only, or 4) common to the females only.

Thirty-five of the 217 responses were common to all subjects, and 13 of these common items were consistent behaviors throughout the study. Twenty-five responses were common to 4 out of the 5 participants, 10 responses were common to the males only, and 8 were common to the females only.

Behavioral changes as identified by the psychological inventory were realized during the period of investigation (see Appendix F, Table 13).

Stress Index

Part A of the Stress Index examined the athlete's perceptions of stressful situations in his/her general environment, and Part B attempted to identify specific athletic behaviors or feelings that could indicate stress. Responses were categorized as being a) worse than normal/usual, b) about normal, or c) less stressful/better than usual.

Part A. Five of the six subjects had relatively stable patterns throughout the study period. There were no dramatic shifts among any of them. Intra-subject and inter-subject responses were individual; no patterns were visually obvious (see Figures 10 and 11).

M3 showed an initially higher stress pattern during Phase 1, which was reduced during the taper. Responses during Phase 3 were relatively stable and of a low magnitude.

Part B. The intra-subject patterns of response were more varied than Part A. The time over which stress signs appeared was individual. Some scores were elevated only for a day or two (F3, M2, M3), whereas others had more extended stress periods (F2, M1). Common to all subjects

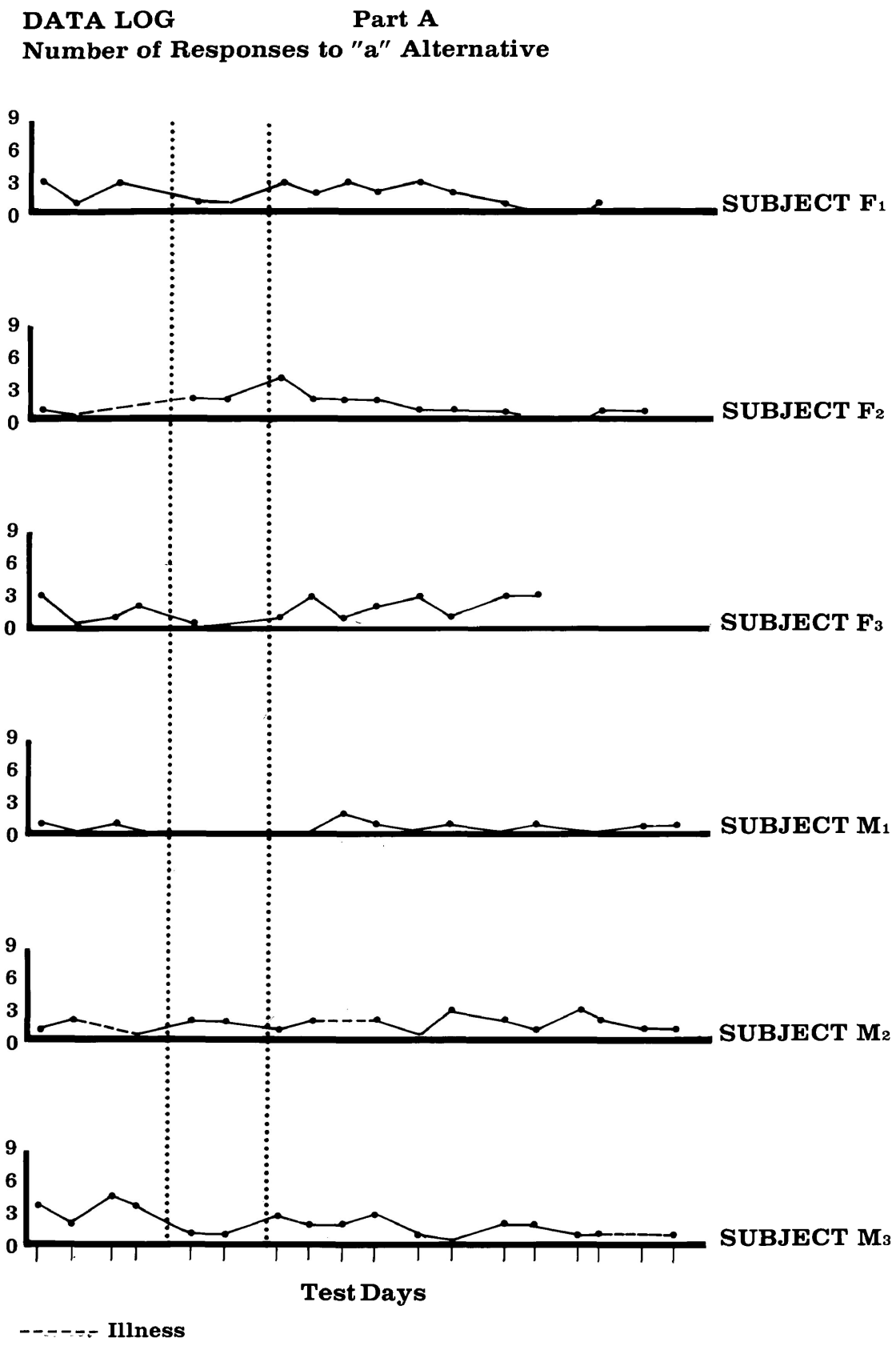

Figure 10. Worse than normal stress in the athlete's general environment.

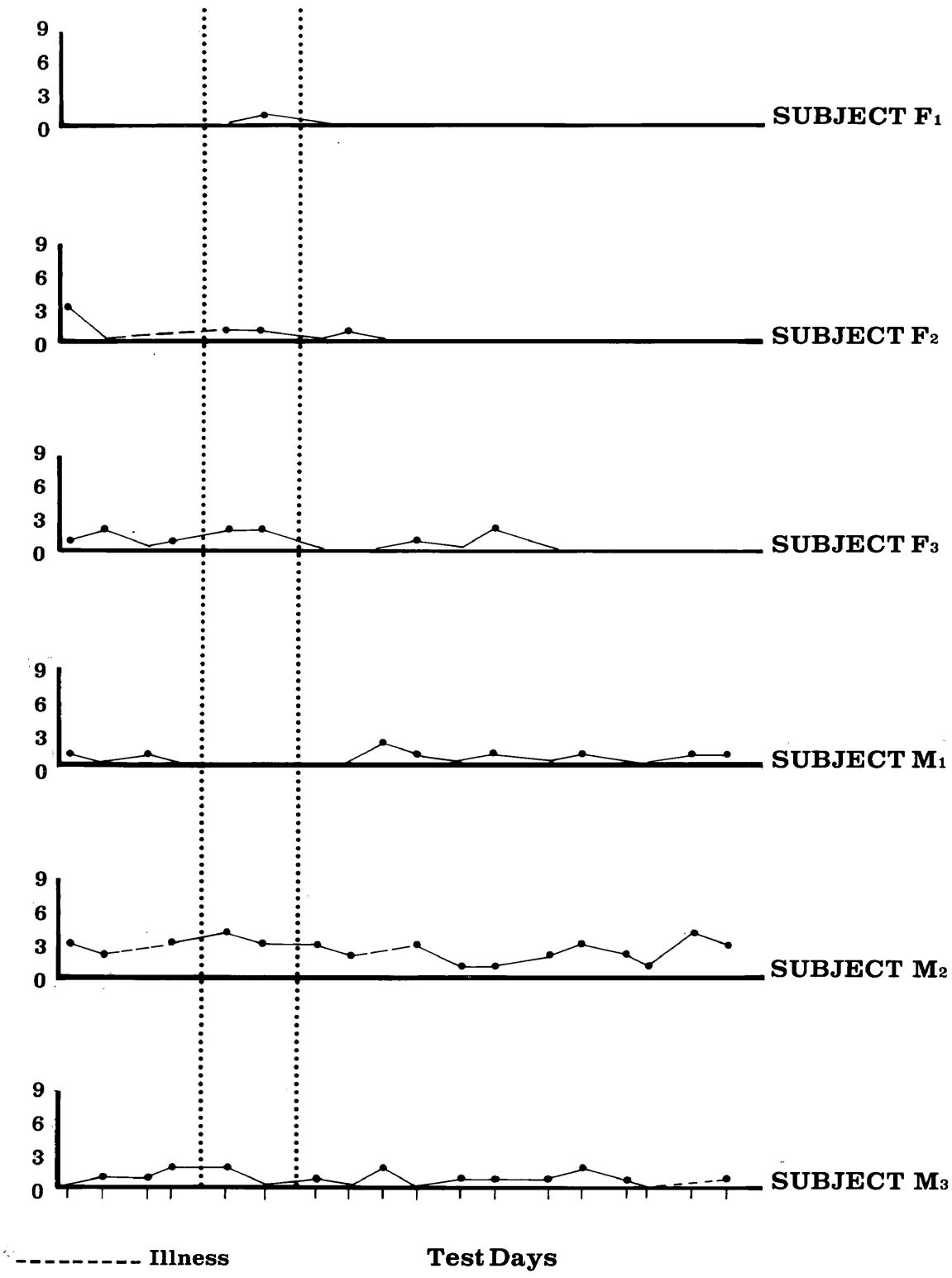

Figure 11. Less stress than usual in the athlete's general environment.

were stress days during the early stages of Phase 3. The duration of the stress varied from one to five observation days (see Figures 12 and 13).

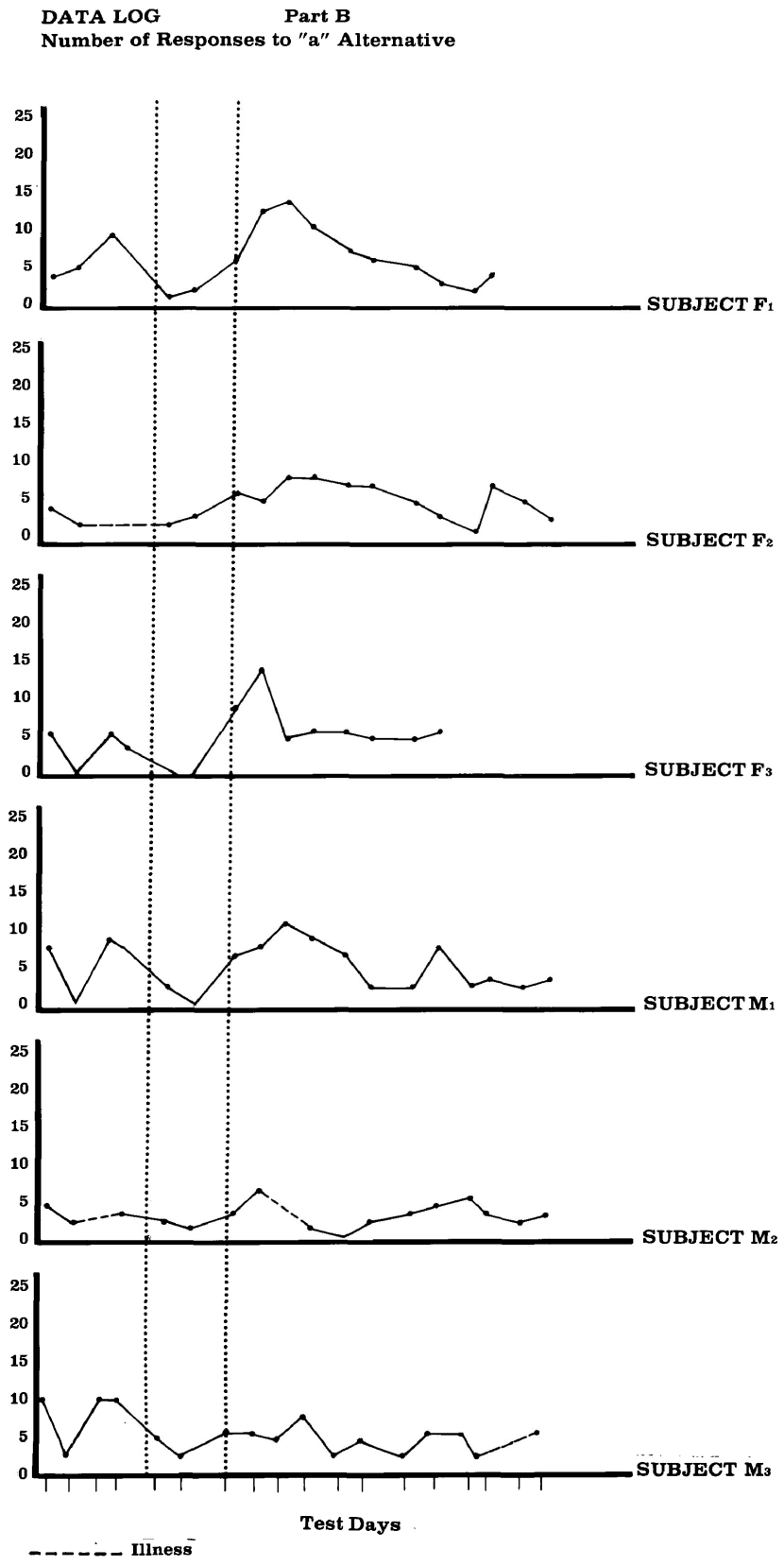

Figure 12. More stress than normal in training environment.

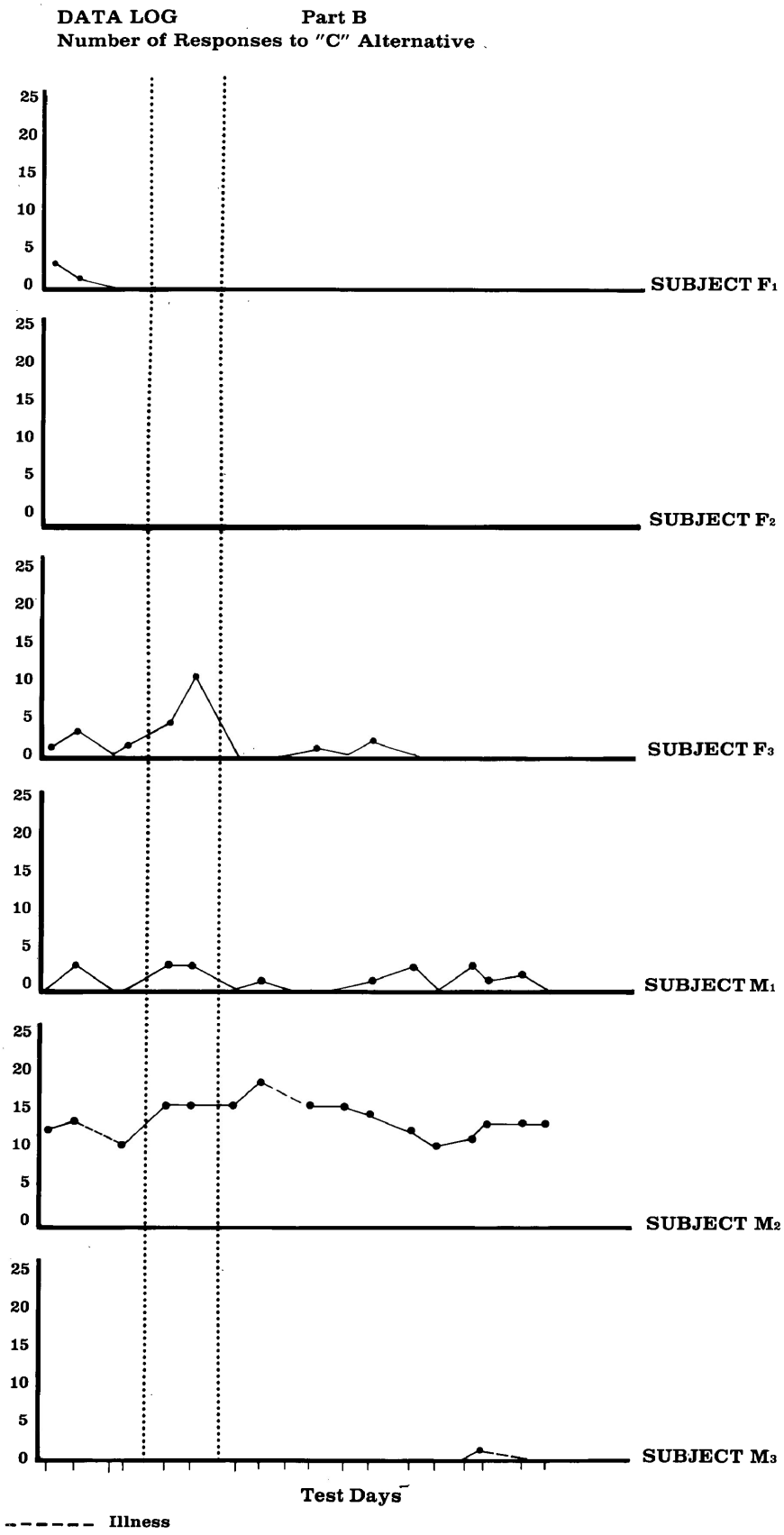

Figure 13. Less stress than normal in training environment.

Chapter V

DISCUSSION

The purpose of this investigation was to monitor a series of multi-disciplinary indices associated with swimming performance in age-group swimmers during a period of serious training. By observing athletes carefully, and by noting those changes which may prove to be useful and objective measures of the state of training stress, a coach may be able to predict the adaptation of athletes. Coach-implementable tests that are functional, easy to administer, and inexpensive may be of assistance to a coach of age-group swimmers. This thesis attempted to identify such tests.

Intra-subject variations were unique to the individual subjects, and no particular patterns were visually obvious over the three phases of the observation period. Inter-subject responses did not reflect any overall patterns that appeared to coincide with the cycles of training. The results of this study of three female and three male age-group swimmers indicated individual responses to the stress of training that were independent of the overall training load.

The values of the intra-subject parameters varied within certain limits. Sometimes a rogue point appeared, but the value soon returned within the normal range. The values of the various inter-subject parameters did not necessarily fall within the same ranges. The values varied, and the ranges of these variations were individual.

The main implication of these results for the theory of coaching may be to reinforce the concept that each athlete is an individual. His/her responses to training are unique, as are his/her abilities to handle physiological and psychological stressors. Testing procedures and the

interpretation of results should appreciate an athlete's particular ability to handle stress. Many coaches evaluate training programmes based on the test results of a group of athletes. The results of this study imply that this group approach may be methodologically incorrect. What is appropriate for one athlete may not be appropriate for another.

The variability of the intra-subject and inter-subject responses also indicates that the timing of testing procedures within a training cycle may be important. A pre-test/post-test format may produce results that could lead a coach to incorrectly interpret the implications of the training programme. The values of the parameters in this study varied; the longitudinal data over nine weeks indicated that there were ranges within which each subject cycled without any adverse physiological or psychological repurcussions. Had a pre-test/post-test format been used, the test day may have occurred on a "low" day or a "high" day. Would such a result reflect the real status of the athlete? Erroneous conclusions could result from a once only testing procedure. The results of this study would indicate that training programmes and their specific stress effects should be monitored on a regular basis throughout a period of training. Acceptable ranges of individual variability may be developed for each athlete. Movement within a particular range may indicate stability; values outside the particular range may indicate impending or actual states of extreme stress. Pre-test/post-test formats do not produce sufficient data to enable the coach to develop such tolerance ranges.

That none of the parameters reflected characteristic responses to the variations in the training load may indicate 1) that the tests were not functional, or 2) that the athletes were operating within stable ranges

during the period of the study. Longitudinal data over a longer period of time may clarify this point. The available data do not appear to be sufficient to make a definite interpretation. One conclusion could be that tests should be conducted over several months, and even over the years of an athlete's career. Producing basic data during an individual's formative years may enable the coach to specify the testing protocol in the future for each particular athlete. Redundant tests could be eliminated. The time frame of this study did not appear to have been long enough to indicate whether a certain test was/was not functional, or whether the delimiting values of possible ranges of stability could be defined. Tests over a longer period of time should be conducted.

Anthropometric Measurements

A continued loss of weight below an athlete's normal level is a sign of overtraining (Morehouse & Miller, 1976), or chronic fatigue resulting from a failing adaptation to the stress of training (Carlile, 1962). Five of the subjects maintained their body weight during the study period, and one subject (F2) realized a modest positive change. Body weight measurements did not indicate any chronic fatigue symptoms.

That five of the six subjects realized no change in their skinfold measurements supports previous studies (Cook & Brynteson, 1973; Katch, Michael, & Jones, 1969; Smith & Stransky, 1986) which indicated that body density changes after physical training of various lengths were marginal or nonexistant. That one subject (F2) realized a positive change could be due to a growth spurt that often occurs in adolescents.

The stability of the body weight and skinfold measurements together indicated no particular responses to the training load during this study.

Hematological Considerations

The hemoglobin levels of the six subjects varied during the study; this supports the literature (Carlile, 1963; Counsilman, 1968; Puhl & Runyan, 1980; Rompotti, 1969; Rushall & Busch, 1980; Talbot, 1969). However, there were no consistent changes among any of the subjects; this supports other studies (Akgun, Tartaroglu, Durusoy & Kocaturk, 1974; Weswig & Winkler, 1974; Wirth, Lohman, Avallone, Shire, & Boileau, 1978). As with the hemoglobin values, the hematocrit levels fluctuated widely on an irregular basis. That the patterns of individual hematological responses during this period of training were unique for each athlete supports the findings of Rushall and Busch (1980).

The Hb, Hct, and M.C.H.C. measurements offered no indications of particular responses to the overall training load, whether they were considered individually, or in various combinations. However, there emerged a discernable pattern whereby Hb values at the beginning of the week were usually higher than those at the end of the week. After a rest day on the weekend, the subjects were somewhat recovered; Hb values usually recovered, as well. This was a short-term phenomenon. Its value in predicting chronic fatigue would be of assistance only if the Hb values remained depressed over a longer period of time. Such an event may possibly be a preliminary warning sign; the coach's further investigations would be warranted.

Extended periods of depressed hematological values did not occur in this study. A conclusion may be that the athletes were in stable adaptation throughout the period of the investigation.

Cardiovascular Considerations

Symptoms of chronic fatigue include an elevated resting pulse rate

and a lowered blood pressure, which is reflected primarily in a progressive fall of the systolic pressure (Morehouse & Miller, 1976). During this study, none of the subjects demonstrated either a consistently elevated resting pulse rate or a consistently lowered blood pressure, either systolic or diastolic.

From the supine to the standing positions, an undue increase in heart rate and a fall in blood pressure are considered to indicate poor vasomotor stability (Morehouse & Miller, 1976; Shephard, 1972). Some heart rate and blood pressure changes occurred during the study, but there was no systematic pattern of coordinated responses between these two parameters. Cardiovascular values were individual and relatively stable. Warning signs of approaching states of chronic fatigue were not evident.

Psychological Considerations

Psychological and sociological information in sport will be helpful only to the extent that the coach can interpret the data properly and specifically in his or her own situation (Cratty, 1973; Rushall, 1979b). Because psychological tests that deal with personality constructs are purely descriptive and vague, behavior analysis techniques may be more appropriate in a sporting environment (Rushall, 1979b). Behavioral changes as identified by the psychological inventory were realized during the period of this investigation.

Only 6.0% of all the responses on the inventory indicated established behaviors in the six subjects throughout the study, and just 10.1% of the responses were at least common to all the subjects. Therefore, 16.1% of all the responses involved all the participants. That the remaining responses (83.9%) involved relative degrees of individual involvement reinforces the uniqueness of these six athletes' behaviors. A group

approach to ongoing team situations by the coach would be appropriate for only a very few items; those were identified. The coach can realize that some training and/or competition situations are important for all athletes, but his/her approach may have to vary from individual to individual. The most important conclusion may be that the vast majority of athlete behaviors are individual; this implies that a close communication between the coach and the individual athlete is necessary.

It was not the objective of the psychological inventory to predict approaching states of chronic fatigue. However, the improved communications that the results may facilitate could result in an overall stress reduction that might enhance training and competition performances. Further research is necessary in this regard.

The sociological scale indicated unique response patterns that were relatively stable for each individual. Cratty (1973) suggested that changes in group dynamics during a season of training can vary, so that subgroups of athletes feel closer to each other. Perhaps the small population of this study may not have resulted in a sufficiently dynamic effect. On the other hand, the relative stability may be a reflection of the overall trend of the other parameters. The athletes may have been stable, and in good emotional and physical health.

The Daily Analysis of Life Demands for Athletes (Rushall, 1975) locates the source of stress in a swimmer's life, and it is also used to indicate symptoms of acute debilitating fatigue. Part A of the stress index seeks to identify whether certain aspects of the athlete's everyday living are more or less stressful than usual. The results of this study indicated that there were no unusual everyday stresses throughout the period of investigation in five out of the six subjects. One subject (M_3) had a

higher level at the beginning, and then it decreased to a low and stable pattern.

Part B seeks to identify whether certain aspects of the individual's athlete environment are more or less stressful than usual. The results of this study indicated that the stressful events in the athletic environment varied more than those in everyday life. This would seem logical, as the training program of any serious athlete is important to him or her. Upsetting situations in a performance activity can prevent an athlete from realizing his/her objectives. The effects of such upsets are measurable in terms of training and/or competition times.

That stress responses were individual in most cases agrees with the data from the other parameters. However, common to all subjects were stress days during the early stages of Phase 3. This may be due to the resumption of a heavier work load, after the taper phase. Getting back into hard work may have been uncomfortable for the athletes.

This thesis attempted to monitor a series of multi-disciplinary indices associated with the performance of age group swimmers during a period of serious training. The population of the study was small, and the time of the study was only nine weeks. Future studies using larger groups over longer periods of time may produce more varied responses. A larger data base may facilitate the delimitation of ranges of stability for each individual.

The age-group swimmers in this study were children. The responses of mature, elite athletes who can handle significantly heavier workloads may be different. The pain threshold of adults may be higher than in children, and the stress of training may be more acute in the elite than in the age-group swimmer. Perhaps the parameters in this study may produce more

dramatic responses in such a situation.

The lack of consistently extreme values in the subjects' responses could indicate that the training load was appropriate for these six individuals. The catabolic and anabolic processes were in balance. Chronic fatigue was prevented by the correct alternation of work and recovery periods. This would reflect sound coaching methodology.

This study was exploratory. Further studies should be conducted with some or all of the test parameters. They were easily administered, and time efficient. More frequent measurements over a longer period of time with a larger population should be considered.

Based on the data from this study, it is impossible to determine precisely which tests are functional. Perhaps volunteer adult subjects could be used in a future study, during which extreme training loads would be imposed over an extended period of time. Dramatic responses may be forthcoming. However, the ethics of such an approach may be questioned.

Two major considerations were raised concerning testing as a result of this study. When athletes are adapted, as opposed to measuring from a non-trained to a trained state (Carlile & Carlile, 1961), obvious changes in parameters of the type used here do not occur. Perhaps a more precise multi-dimensional picture of the athlete needs to be considered, rather than a single indicant change that is obvious. Secondly, there is a popular trend within Canada at this time to conduct isolated testing camps for athletes in training. If the subjects in this study were related to the types of individuals who attend such camps, then isolated measurements and inter-individual comparisons are not warranted. It is interesting to note that some of the subjects in this study had attended such testing camps. Consequently, the validity and rationale for conducting such camps

must be seriously questioned.

Finally, it must be realized that a vast amount of the research involved with adaptation has concerned untrained individuals being trained. The findings of such studies are not appropriate for researches which commence with adapted athletes. The science of the adapted athlete may be vastly different to the science of the adapting person. The generalization of findings from adapting studies to adapted studies is frequently evidenced. Perhaps a completely different set of indicants and tests needs to be developed for trained athletes, as opposed to using the traditional tools and methods that are sensitive only to the large changes in adaptation. This feature needs to be considered seriously by sport scientists.

This study has not drawn specific conclusions. The data do not permit any attempt to do so. However, some speculations can be made.

Perhaps many coaches do not appreciate the uniqueness of their individual athletes. Numerous coaching and instructional books prescribe specific training approaches to develop specific physiological or psychological characteristics. The scientific research of recent years is clarifying many physiological question areas, but it is also showing that a variety of training protocols can result in similar performance gains. The suitability of a particular training regimen depends on the specific needs of a particular athlete. An individual approach is needed.

The requirements of an athlete may change over time. Gathering longitudinal data may help the coach and athlete anticipate future needs. Short-term studies are often inconclusive; pre-test/post-test formats may be inappropriate in an athletic environment.

This study did not attempt to answer specific questions; its objective

was to explore. Certain questions have been posed for future researchers. Their answers would enhance the science of coaching.

Chapter VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Exercise stress should be monitored in athletes during periods of strenuous training. By noting those changes that are sensitive and objective measures of the state of exercise stress, a coach may be able to predict the adaptation of athletes. Impending states of acute or chronic exhaustion may be anticipated, and prevented.

This study monitored a series of multidisciplinary indices associated with swimming performance in age-group swimmers throughout a period of serious training. The study group comprised three girls and three boys, all of whom were members of the Thunderbolts Swim Club in Thunder Bay, Ontario. The six subjects were the club's top performers.

Certain physiological, psychological, and sociological parameters were explored during a nine-week period. The test protocol included measurements of 1) standing height, 2) body weight, 3) skinfold, 4) resting heart rates, 5) resting systolic and diastolic blood pressures, 6) hemoglobin, 7) hematocrit, and 8) mean corpuscular hemoglobin content. A sociological scale, a psychological inventory, and a stress index completed the test battery.

The study was based on an intra-subject, case study design. Graphs were presented to illustrate any trends in the various parameters in each individual. No statistical analyses were intended. Changes had to be visually obvious to be recognized. The number and types of changes were compared between subjects.

Conclusions

This study indicated the following conclusions:

1) Intra-subject variations were unique to the individual subjects, and no particular patterns were visually obvious over the three phases of training.

2) Individual responses to the stress of training were independent of the overall training load.

3) The values of the intra-subject parameters varied within certain limits. However, the values of the various inter-subject parameters did not necessarily fall within the same ranges. The ranges were individual.

4) Evaluating training programmes based on the test results of a group of athletes may be methodologically incorrect. Individual assessments may be necessary.

5) The timing of testing procedures within a training cycle may be important. A pre-test/post-test format may lead to erroneous conclusions. Longitudinal data on individual athletes is necessary.

6) Gathering test data throughout an athlete's career may enable the coach to specify a testing protocol unique to each individual.

7) Establishing tolerance ranges within which an athlete's parameters can vary may be more functional than the traditional method of describing one finite value as a measure of adaptation. Values exceeding those limits may indicate extreme exercise stress.

Recommendations

It is recommended that this study be replicated. Future researchers should consider the following points:

1) The format could be applied to other sports.

2) Post-adolescent athletes should be considered as potential subjects.

3) The number of subjects and the time of future studies should be increased.

4) Other measurements should be considered.

5) Future studies should attempt to more clearly delineate between adapting and adapted athletes. As the sciences of the two groups may be quite different, the population as well as the individual responses may vary considerably. More precise measurement techniques may be necessary for the adapted athlete.

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APPENDIX A

Informed Consent Form

This study is the basis of a thesis to be presented to the Faculty of University Schools, Lakehead University by W. Alan W. Roaf in partial fulfillment of the requirements for the Degree of Master of Science in the Theory of Coaching. The observation period will be from January 12 to March 15, 1981. The scope of the study will be delimited to tests of standing height, body weight, skinfold thickness, resting heart rate, resting blood pressure, hemoglobin, and hematocrit. A stress index, a psychological inventory, and a sociological scale will complete the battery of tests.

The data gathered throughout the study period will be available to you and your coach at any time. However, this information will not be available to anyone else without your written permission. You are free to withdraw from the study at any time without fear of reprisals in your training group.

All data collected during the study will become the property of W. Alan W. Roaf, and it cannot be published or reproduced in any form without his permission in writing.

I/We have read the above statement, understand it, and give my/our permission for _____ to participate in this study.

Signed: _____ Parent/Guardian

Signed: _____ Parent/Guardian

Date: _____

Informed Consent Form (continued)

I have read the above statement, understand it, and give my informed consent to take part in the study.

Signed: _____

Date: _____

APPENDIX B

Table 1. Height Measurements

Date	Centimetres					
	F1	F2	F3	M1	M2	M3
January 8	156	160	159	170	177	173
March 10	156	160	159	170	177	173

APPENDIX B

Table 2. Body Weight Measurements

Date	Kilograms					
	F1	F2	F3	M1	M2	M3
January 8	47.8	47.5	45.5	59.7	50.3	54.2
15	48.1	48.5	45.6	60.7	51.3	54.5
27	48.0	49.5	45.1	61.9	51.6	55.0
February 5	48.5	49.4	45.5	63.1	51.3	55.7
11	48.4	49.6	45.8	62.5	51.5	55.7
24	47.8	50.0	46.9	60.4	51.6	55.8
March 10	away 1	49.8	sick	61.8	51.9	54.7

Note. 1. F1 was away at a swim meet.

APPENDIX B

Table 3. Total of the Four Skinfold Thickness Measurements

		Millimetres					
		F1	F2	F3	M1	M2	M3
January	8	32.0	22.2	28.7	15.7	18.0	16.4
	15	32.5	24.3	28.4	16.7	16.7	15.7
	27	32.0	26.3	28.0	17.9	14.2	14.7
February	11	30.5	27.2	28.8	17.3	15.9	16.1
	24	32.3	29.4	33.1	16.5	16.2	16.2
March	10	away 1	28.1	sick	17.7	17.0	16.6

Note. 1. F1 was away at a swim meet.

APPENDIX C

Table 4. Resting Heart Rates

Date		F1		F2		F3		M1		M2		M3	
		Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing
January	15	60	72	64	88	60	84	59	68	60	60	64	84
	22	away 1		62	76	70	90	63	69	60	64	63	84
	28	59	78	58	72	66	78	60	72	60	66	60	84
February	4	54	72	63	75	54	60	60	78	60	60	68	80
	12	56	66	62	72	60	70	58	74	60	60	66	76
	17	63	66	60	75	60	78	54	64	69	60	64	80
	25	54	60	64	72	60	76	54	60	60	76	68	78
March	11	away 1		56	80	sick		60	72	60	66	66	84

Note. 1. F1 was away at swim meets.

APPENDIX C

Table 5. Resting Systolic Blood Pressures

Date		F1		F2		F3		M1		M2		M3	
		Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing
January	15	110	90	90	94	102	96	132	120	115	118	104	94
	22	away 1		sick		110	110	120	118	away 2		110	122
	28	120	110	110	100	110	106	132	110	110	116	110	120
February	4	120	115	120	117	108	105	130	115	100	100	116	115
	12	120	115	118	116	110	106	132	118	104	110	104	110
	17	110	100	110	100	106	104	120	120	110	100	106	112
	25	110	100	110	110	110	110	130	120	115	104	110	115
March	11	away 1		120	110	sick		120	110	110	108	108	95

Note. 1. F1 was away at swim meets.

2. M2 was away at swim meets.

APPENDIX C

Table 6. Resting Diastolic Blood Pressures

Date		F1		F2		F3		M1		M2		M3	
		Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing	Supine	Standing
January	15	50	48	60	72	68	72	62	70	45	78	56	68
	22	away		sick		70	80	58	86	away		55	98
	28	56	80	58	78	60	80	70	82	50	84	45	80
February	4	68	80	86	78	80	70	50	80	60	70	68	75
	12	60	70	70	65	68	67	72	85	56	68	56	65
	17	60	70	60	60	60	80	70	80	50	70	58	70
	25	60	60	60	60	60	60	60	80	55	60	60	70
March	11	away 1		60	80	sick		60	80	60	70	60	70

Note. 1. F1 was away at swim meets.
2. M2 was away at a swim meet.

APPENDIX D

Table 7. Hemaglobin Measurements

Date	gm % Hb					
	F1	F2	F3	M1	M2	M3
January 8	sick	sick	13.2	13.5	15.2	14.2
12	13.7	14.2	14.0	14.7	16.2	15.4
15	14.0	14.2	13.1	13.2	15.4	14.2
20	13.2	sick	13.2	14.2	15.0	14.0
22	away 1	sick	13.7	13.7	away 1	14.2
26	14.7	14.4	14.4	15.2	16.1	14.4
27	13.5	13.6	13.9	13.2	16.0	14.4
28	14.2	14.4	14.0	14.4	16.4	14.1
29	14.4	13.9	14.4	14.9	16.0	14.7
February 5	14.0	14.2	13.9	14.0	15.7	14.5
9	14.4	14.7	14.0	15.0	sick	14.5
12	13.4	14.4	13.8	14.0	17.82	14.2
16	13.7	13.8	14.2	14.9	15.4	14.7
19	13.2	13.4	14.0	14.8	14.8	14.2
23	away 3	13.5	13.7	14.4	away 3	away 3
26	13.2	14.1	13.7	14.2	15.8	14.7
March 2	14.4	13.8	sick	14.7	15.8	15.0
5	13.4	15.0	sick	14.4	16.2	14.2
9	14.2	14.9	sick	14.9	15.4	sick
12	away 4	14.7	sick	14.7	14.4	14.7

Note. 1. F1 and M2 were away at a swim meet.
2. M2 had vomited prior to the Hb measurements, and this result possibly reflects dehydration.
3. F1, M2, and M3 were away at a swim meet.
4. F1 was away at a swim meet.

APPENDIX D

Table 8. Hematocrit Measurements

Date	% Hct					
	F1	F2	F3	M1	M2	M3
January 8	sick	sick	37.8	39.5	44.0	41.0
12	38.0	41.0	37.0	41.0	46.0	43.0
15	38.8	40.0	36.0	39.0	42.0	41.0
20	39.0	sick	38.0	39.5	45.5	43.0
22	away 1	sick	38.5	39.0	away	43.0
26	41.5	38.5	39.0	43.0	45.0	41.0
27	39.0	39.0	40.0	40.0	42.5	45.0
28	39.0	40.0	37.8	42.0	46.0	42.0
29	39.0	40.0	37.0	42.5	43.0	42.0
February 5	40.0	38.0	38.5	39.5	44.0	42.0
9	39.0	40.0	39.5	43.0	sick	42.0
12	39.0	39.0	40.0	41.0	50.02	40.0
16	39.0	38.0	39.0	42.0	43.0	41.0
19	38.0	38.0	39.5	42.0	42.0	41.0
23	away 3	38.5	39.0	40.0	away 3	away 3
26	38.0	40.0	39.0	41.5	45.0	43.0
March 2	39.0	39.9	sick	41.5	44.5	44.0
5	38.0	41.0	sick	42.0	46.5	41.0
9	39.5	40.0	sick	43.0	44.5	sick
12	away 4	41.0	sick	42.5	43.0	42.5

Note. 1. F1 and M2 were away at a swim meet.
2. M2 had vomited prior to the Hct measurements, and this result possibly reflects dehydration.
3. F1, M2, and M3 were away at a swim meet.
4. F1 was away at a swim meet.

APPENDIX D

Table 9. Mean Corpulscular Hemoglobin Concentration

	M.C.H.C. %					
	F1	F2	F3	M1	M2	M3
January 8	sick	sick	34.9	34.2	34.6	34.6
12	36.1	34.6	37.8	35.9	35.2	35.8
15	36.1	35.5	36.4	33.9	36.7	34.6
20	33.9	sick	34.7	36.0	33.0	32.6
22	away 1	sick	35.6	35.1	away 1	33.0
26	35.4	37.4	36.9	35.4	35.8	35.1
27	34.6	34.9	34.8	33.0	37.7	32.0
28	36.4	36.0	37.0	34.3	35.7	33.6
29	36.9	34.8	38.9	35.1	37.2	35.0
February 5	35.0	37.4	36.1	35.4	35.7	34.5
9	36.9	36.8	35.4	34.9	sick	34.5
12	34.4	36.9	34.5	34.2	35.62	35.5
16	35.1	36.3	36.4	35.5	35.8	35.9
19	34.8	35.3	35.4	35.2	35.2	34.
23	away 3	35.1	35.1	36.0	away 3	away 3
26	34.7	35.3	35.1	34.2	35.1	34.2
March 2	36.9	34.6	sick	35.4	35.5	34.1
5	35.1	36.6	sick	34.3	34.8	34.6
9	36.0	37.3	sick	34.7	34.6	sick
12	away 4	35.9	sick	34.6	33.5	34.6

Note. 1. F1 and M2 were away at a swim meet.
2. M2 had vomited prior to the Hb and Hct measurements.
3. F1, M2, and M3 were away at a swim meet.
4. F1 was away at a swim meet.

APPENDIX E

Table 10. Sociology Scale

		Number of Responses											
		F1		F2		F3		M1		M2		M3	
		W1	W/N2	W	W/N	W	WN	W	WN	W	WN	W	WN
January	9	sick		sick		8	2	6	0	6	6	2	4
	14	3	5	3	9	8	2	6	1	6	6	3	4
	19	3	8	5	8	7	2	6	2	6	6	2	4
	24	away 3		sick		8	2	6	2	away 3		2	4
	30	4	5	6	8	7	2	6	0	6	5	3	4
February	5	5	4	6	9	7	2	8	0	6	6	3	4
	10	3	4	5	7	8	2	7	0	6	6	3	4
	16	3	4	3	6	8	2	4	0	sick		5	4
	20	3	3	5	6	8	0	7	0	6	6	2	4
	28	5	3	1	6	-	-	7	0	6	6	2	5
March	6	5	3	1	5	-	-	4	0	7	5	3	4
	8	-	-	1	6	-	-	7	0	7	4	3	4

Note. 1. W: would like to work with
2. WN: would not like to work with
3. F1 and M2 were away at a swim meet

APPENDIX F

Table 11. Specific Responses to the Psychological Inventory

	Subject				
	F1	F2	F3	M1	M3
1) Other's poor opinion of his/her work upsets attitude.	1	-	2	-	-
2) Waits to be sure he/she is correct before arguing.	12	12	12	12	-
3) Sometimes jealous of other swimmers.	-	-	-	-	-
4) Respects parental role in swimming world.	12	-	-	12	12
5) Difficult to accept negative decision.	-	-	-	-	1
6) Frequently considers coach to be unreasonable.	-	-	-	2	-
7) Unable to handle unusual circumstances.	-	-	-	-	2
8) Needs coach to direct him/her.	1	2	-	-	-
9) Angers quickly.	-	-	-	-	2
10) No feeling of ill-health or pains.	-	-	-	2	12
11) Feelings of ill-health and pains do occur.	12	12	12	-	-

NOTE:

Key: 1 = Decreased
12 = Consistent/Established
2 = Increased

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
12)	Feels that he/she is one of the hardest workers.				
	-	-	-	12	-
13)	Attempts to be conscientious.				
	12	-	12	12	2
14)	Proceeds with original intentions despite difficult obstacles.				
	-	-	-	12	-
15)	Loses composure when excited.				
	1	-	-	-	-
16)	Maintains composure when upset.				
	-	1	-	2	-
17)	Swimming dreams upset sleep.				
	2	-	1	-	1
18)	Applies himself/herself to all difficulties.				
	2	-	-	-	-
19)	Unfamiliar pools do not affect performance.				
	12	1	12	12	2
20)	Awkward mistakes of others do not upset him/her.				
	-	-	1	12	12
21)	Occassionally grouchy and wants to work alone.				
	12	12	1	2	12
22)	Extremely upset when things go wrong.				
	12	2	12	-	-
23)	Restless sleeps the night before competition.				
	2	-	-	-	1
24)	Rarely affected by any swimming troubles.				
	12	-	-	2	-
25)	Small problems are distracting prior to important competitions.				
	2	-	-	-	-

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
26)	Able to calm down quickly after upsetting circumstances.				
	-	-	-	12	2
27)	Upsetting circumstances affect him/her for a long time.				
	-	-	2	-	-
28)	Trembling or nausea prior to important competitions.				
	12	-	1	-	-
29)	Moderate anxiety about his/her swimming.				
	-	-	1	-	1
30)	Criticizes coaches and other swimmers.				
	-	-	-	-	1
31)	Makes sarcastic remarks to other swimmers.				
	-	-	-	1	-
32)	Comes forward on social occassions for swimming.				
	-	-	-	2	-
33)	Cannot tolerate conceited, loud swimmers.				
	-	-	-	1	-
34)	Reluctant to discuss feelings about swimming.				
	2	1	2	2	1
35)	Guilty feelings when wrongly criticized.				
	12	-	-	-	-
36)	Worried when others say something bad about him/her.				
	2	2	1	-	-
37)	Makes decisions based on well thought-out reasons.				
	2	2	-	12	-
38)	Says things just as they occur to him/her.				
	-	-	-	1	-
39)	Embarrassed when suddenly made focus of attention.				
	2	-	12	-	-

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
40)	Enjoys being with fellow swimmers at social occassions.				
	12	12	12	12	12
41)	Expects complete obedience when in charge.				
	12	-	-	2	12
42)	Adversely affected when publicly criticized.				
	1	-	-	-	-
43)	Perceptive about coaching "deceit".				
	-	-	-	12	-
44)	Organizes his/her equipment well.				
	12	1	12	12	12
45)	Considers his/her characteristics superior to other swimmers.				
	1	-	-	2	-
46)	Irritated when another swimmer mad at him/her.				
	-	-	-	1	-
47)	Seeks revenge when treated unfairly.				
	-	-	-	-	1
48)	Always confident about performing to expectations.				
	-	1	-	-	-
49)	Prefers others to do talking and organizing.				
	-	-	-	-	1
50)	Reacts negatively to bossy swimmers or coaches.				
	-	-	-	1	12
51)	Disheartened when treated badly by others.				
	1	1	-	-	1
52)	Enjoys taking part in swim team matters.				
	1	-	12	12	1
53)	Greatly irritated by small setbacks and problems.				
	-	-	-	-	2

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
54)	Generally polite and quiet.				
	-	-	2	-	-
55)	Prefers to train alone.				
	-	-	-	12	-
56)	Training program should be planned well in advance.				
	12	12	12	12	-
57)	Identifies others who are unjust or selfish.				
	-	-	-	-	2
58)	Readily adopts new training ideas and procedures.				
	2	-	-	-	-
59)	Will not readily adopt new training ideas.				
	-	-	-	-	2
60)	Does not feel like competing in important meets.				
	-	-	-	-	12
61)	Will do foolhardy things for fun at meets.				
	-	-	-	12	2
62)	Keeps emotions to himself/herself.				
	2	-	-	-	-
63)	Prefers others to plan trips.				
	2	-	1	2	1
64)	Prefers to plan to his/her own swimming.				
	-	-	-	12	-
65)	Tenses when thinking about future training and competition.				
	2	2	-	-	1
66)	Upset by distractions during race preparations.				
	2	-	1	2	-
67)	Always produces best effort in race.				
	12	-	2	1	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
68)	Enjoys leadership responsibilities.				
	-	1	2	-	-
69)	Does not enjoy leadership responsibilities.				
	1	2	-	-	-
70)	Can accept advice from other swimmers.				
	12	-	12	-	1
71)	Likes reasons for all coaching directives.				
	12	2	12	12	12
72)	Learns best from coach rather than other swimmers.				
	2	-	2	-	2
73)	Prefers not to follow pool rules.				
	-	2	-	12	1
74)	Small things get on his/her nerves.				
	-	-	-	-	1
75)	Difficulty in forgetting small mistakes in front of others.				
	-	-	1	-	-
76)	More effort/intensity into competition than into training.				
	-	12	2	-	-
77)	Considers himself/herself to be very enthusiastic about swimming.				
	2	-	-	-	-
78)	Training programs should keep him/her busy all the time.				
	-	-	12	12	1
79)	Prefers to do things his/her way.				
	-	1	-	12	2
80)	Tries harder in next race after disappointing race.				
	12	1	1	-	-
81)	Concentrates totally on race preparation prior to event.				
	-	-	-	12	-

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
82)	Swimming is most important activity.				
	12	12	2	12	12
83)	Annoyed when other swimmers fool around in training.				
	-	-	-	2	-
84)	Follows coach's rules for behaviour outside swimming.				
	12	-	12	-	-
85)	Training efforts equal competition effort.				
	-	-	-	12	1
86)	Video or movies are helpful.				
	12	12	12	12	-
87)	Not bothered by pre-race upsets.				
	-	-	-	-	1
88)	Always expects to win races.				
	-	-	-	-	1
89)	Prefers to lead no matter how much effort required.				
	1	1	2	-	-
90)	Prefers to make technical decisions in consultation with coach.				
	2	-	1	-	-
91)	Talks behind the coach's back.				
	-	-	-	-	1
92)	Will spend as much time as necessary in training.				
	12	-	2	12	-
93)	Always arrives early for training.				
	1	1	12	-	12
94)	Attempts new stroke mechanics despite any discomfort.				
	12	12	2	-	-
95)	Good judge of his/her performance abilities.				
	-	-	1	12	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
96)	Frequent doubts and depressions about swimming.				
	-	-	-	-	2
97)	Tries to do everything well at training.				
	12	-	12	12	1
98)	Competes for personal rewards rather than team points.				
	-	12	-	-	12
99)	Never leaves training early.				
	-	2	-	12	2
100)	Sometimes leaves training early.				
	-	-	2	-	-
101)	Maintains intensity in training despite fatigue.				
	1	-	-	2	-
102)	Prefers coach's criticism to be offered privately.				
	1	1	1	-	-
103)	Can train alone if coach's instructions adequate.				
	2	-	-	12	2
104)	Prefers to swim repeats alone.				
	-	-	1	12	-
105)	Considers weight-watching to be important.				
	12	1	12	-	-
106)	Controlling weight is not important.				
	-	-	-	1	12
107)	Bad tempered at training when not feeling well.				
	-	1	-	-	12
108)	Coach's criticisms bother him/her.				
	1	1	-	-	-
109)	Seldom misses training due to illness.				
	1	-	1	12	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
110)	Frequent, unexplained changes in training weaken coach's credibility.				
	-	-	-	-	2
111)	Always tells the truth.				
	12	2	12	1	12
112)	Always strives for better performances.				
	12	12	12	12	12
113)	Prefers hard training sessions.				
	-	-	-	12	2
114)	Keeps to training program as posted.				
	12	-	1	12	12
115)	Always tries his/her hardest at training.				
	12	-	-	2	-
116)	Always listens to what the coach says.				
	12	-	12	-	-
117)	Will miss practice for something more interesting.				
	-	-	1	-	-
118)	Likes doing times during training to see improvement.				
	2	-	1	12	12
119)	Likes hard, demanding training sessions.				
	-	-	-	12	2
120)	Prefers to warm-up alone prior to important race.				
	2	12	-	12	12
121)	Always nervous and tense prior to important race.				
	12	2	12	2	12
122)	Prefers to be left alone prior to important race.				
	2	-	-	12	2
123)	Does not worry about other competitors.				
	-	-	-	1	2

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
124)	Can regain composure if troubled before race.				
	2	-	1	12	-
125)	Cannot regain composure if troubled before race.				
	-	-	-	-	2
126)	Likes to have races planned in detail.				
	2	-	1	2	-
127)	Prefers to have race plan with options.				
	2	-	-	2	-
128)	Does not need option plan in a race.				
	-	-	-	-	1
129)	Mentally rehearses frequently prior to race.				
	2	2	12	12	12
130)	Concentrates on approaching race throughout prerace period.				
	2	-	-	12	1
131)	Concentrates on moving fast and far when on blocks.				
	12	1	-	-	-
132)	During race, concentrates on how much it will hurt.				
	-	2	2	-	1
133)	Never goes out as fast as possible in first half.				
	1	2	-	12	1
134)	Listens for gun, rather than thinking about fast movements at start.				
	-	1	-	-	12
135)	Prefers to set his/her own pace.				
	2	-	-	12	2
136)	Prefers not to set his/her own pace.				
	-	1	2	-	-
137)	Varies race plan according to other swimmers.				
	-	1	-	-	-

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
138)	Maintains race plan despite other swimmers.				
	2	-	2	-	-
139)	Mainly concentrates on techniques during race.				
	2	-	-	-	-
140)	Does not concentrate on technique during race.				
	-	12	-	-	12
141)	Thinks of other swimmers during race.				
	-	-	-	-	1
142)	Holds some effort in reserve for a fast finish.				
	-	-	-	-	1
143)	Tries harder as fatigue builds.				
	12	-	1	12	-
144)	Times finishing sprint so that he/she is totally exhausted at end.				
	2	-	-	12	2
145)	Always feels he/she could have performed better.				
	-	2	-	1	12
146)	Concentrates on technique when tired.				
	12	-	12	-	-
147)	Able to vary areas of concentration throughout race.				
	2	-	-	1	-
148)	Uses distraction techniques to alleviate feeling of pain.				
	2	-	-	1	12
149)	Would like to "psych-out" other swimmers.				
	-	-	-	12	1
150)	Detailed race plan enhances performance.				
	-	-	-	12	-
151)	Strives for best effort despite poor race position.				
	12	-	1	12	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
152)	Worries about anticipated pain during impending race.				
	-	2	-	-	2
153)	Never achieves in races his/her predetermined race times.				
	-	12	-	-	-
154)	Uses race information to modify future plans.				
	2	-	2	12	1
155)	Does not use race information in future plans.				
	-	1	-	-	-
156)	Able to calm down if too excited before race.				
	-	-	-	12	-
157)	Knows how to recover confidence before race.				
	-	-	-	12	-
158)	Does not know how to recover confidence.				
	-	1	-	-	2
159)	Good pace judgement and splitting ability in a race.				
	-	-	-	12	-
160)	Likes coach's praise about training and performing.				
	12	12	12	1	1
161)	Likes praise from other swimmers.				
	1	1	-	-	-
162)	Likes parental interest and approval.				
	12	12	12	12	12
163)	Likes training with his/her friends.				
	12	12	12	12	12
164)	Likes outside friends being interested in his/her swimming.				
	-	12	-	-	2
165)	Likes to stand on victory dias after a race.				
	12	12	2	12	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
166)	Likes frequent coach's comments on technique.				
	1	12	12	2	1
167)	Likes competing with others in every repeat.				
	1	2	1	-	12
168)	Likes training with cooperative swimmers.				
	12	12	12	12	-
169)	Likes swimming because he/she likes coach.				
	12	-	12	-	-
170)	Likes variety in the training program.				
	12	12	12	12	12
171)	Training sessions should always be moderately hard.				
	12	-	2	2	12
172)	Does not like swimming butterfly.				
	-	-	-	1	-
173)	Does not like swimming breastroke.				
	12	12	-	1	1
174)	Likes to learn and practice all four competitive strokes.				
	12	-	12	-	1
175)	Likes his/her training times to improve continually.				
	12	12	12	12	12
176)	Likes maintaining detailed records for monitoring progress.				
	1	-	12	-	-
177)	Likes pushing himself/herself in every session.				
	12	-	2	2	1
178)	Likes getting as much swimming information as possible.				
	12	12	12	12	12
179)	Likes daily feedback about rate of improvement.				
	1	1	2	2	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
180)	Likes knowing the time for every repeat in training.				
	12	1	1	12	1
181)	Likes knowing progress and improvement in all aspects.				
	12	12	1	12	12
182)	Likes to learn as much as possible about swimming.				
	-	-	1	-	-
183)	Likes public recognition through media.				
	1	12	-	12	12
184)	Likes travelling to away meets.				
	12	12	12	12	12
185)	Likes rewards (i.e. badges) for training goals.				
	-	1	-	-	-
186)	Likes receiving medallions, etc. for racing.				
	12	1	1	2	12
187)	Likes name on public record board.				
	-	12	-	2	2
188)	Likes to place frequently in races.				
	12	12	12	12	12
189)	Individual races are more important than relays.				
	1	12	-	12	12
190)	Competition mainly as a means of monitoring improvement.				
	12	-	1	12	12
191)	More important races are more enjoyable.				
	-	-	2	12	2
192)	Improving race times are a motivator for training.				
	12	12	12	12	12
193)	Despite infrequent placings, competing is enjoyable.				
	2	-	12	-	12

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
194)	Likes to qualify for at least one final every meet.				
	12	12	12	12	12
195)	Likes having total yardage as training goal.				
	-	-	-	12	-
196)	Would train for many years to become Olympic champion.				
	12	12	1	12	12
197)	Would like to be selected for National Team.				
	12	12	12	12	12
198)	Likes performance goal for every training repeat.				
	12	-	12	1	12
199)	Likes establishing records in individual events.				
	12	12	-	12	12
200)	Likes improving times in all events, not just specialty.				
	12	12	1	12	12
201)	Would like to qualify and go to National Championships.				
	12	12	1	12	12
202)	Would like to be National Champion in at least one event.				
	12	12	-	12	12
203)	Likes to set own time goals for each meet.				
	2	-	1	12	12
204)	Swimming is enjoyable in itself.				
	2	1	12	-	-
205)	Ultimate benefit of swimming is good health.				
	12	-	12	-	-
206)	Total yardage and effort times are training goals.				
	12	-	12	12	-
207)	Every swim is seen as a challenge.				
	12	-	12	2	-

Table 11. Specific Responses to the Psychological Inventory (continued)

	Subject				
	F1	F2	F3	M1	M3
208)	Selection to club team justifies training.				
	12	1	1	1	12
209)	Swimming is his/her most important concern.				
	12	12	2	12	12
210)	Knows what he/she wants from swimming.				
	12	12	12	12	12
211)	Coach should set racing goals.				
	12	-	12	-	-
212)	Goals of swimming is eventually to be a coach.				
	-	-	1	-	-
213)	Ultimate goals should be set by this swimmer.				
	2	-	-	12	12
214)	Insufficient attention is paid to race preparation.				
	-	-	-	2	-
215)	Displays impatient behaviours.				
	-	-	1	-	-
216)	Displays shaking and trembling behaviours.				
	2	-	2	-	-
217)	Displays nervous behaviours.				
	12	-	12	2	

APPENDIX F

Table 12. Summary of the Psychological Inventory

Direction of Behavior	Number of Responses				
	F1	F2	F3	M1	M3
Increased	37	17	24	26	27
Consistent	71	41	49	82	61
Decreased	21	28	35	17	35

Note. 1. There were 13 behaviors that were consistent in all subjects during the period of the study. These could be considered to be established behaviors (40, 112, 162, 163, 170, 175, 178, 184, 188, 192, 194, 197, 210).

2. There were 22 behaviors that were common to all subjects. However, the directions of the behaviors varied (19, 21, 34, 44, 52, 71, 82, 111, 121, 129, 160, 165, 166, 179, 180, 181, 186, 196, 200, 201, 208, 209).

3. There were 25 behaviors that were common to at least four out of the five subjects (2, 12, 56, 63, 67, 86, 93, 97, 114, 118, 120, 133, 151, 154, 167, 168, 171, 177, 183, 189, 190, 198, 199, 202, 203).

4. There were 10 behaviors that were common to the male subjects only (10, 26, 50, 61, 85, 106, 113, 119, 123, 149).

5. There were 8 behaviors that were common to the female subjects only (12, 22, 36, 80, 89, 102, 105, 204).

APPENDIX F

Table 13. Summary of Individual Behavioral Changes.

F1: other's poor opinion of her work no longer upsets her attitude; no longer needs coach's direction; no longer loses composure when excited; swimming dreams upset sleep; applies herself to all difficulties; restless sleeps the night before competition; small problems are distracting prior to important competitions; reluctant to discuss feelings about swimming; worried when others say something bad about her; makes decisions based on well thought-out reasons; embarrassed when suddently made focus of attention; no longer adversely affected when publicly criticized; no longer considers her characteristics superior to other swimmers; no longer disheartened when treated badly by others; no longer enjoys taking part in swim team matters; readily adopts new training ideas and procedures; keeps emotions to herself; prefers others to plan trips; tenses when thinking about future training and competition; upset by distractions during race preparations; no longer enjoys leadership responsibilities; learns best from coach rather than other swimmers; considers herself to be very enthusiastic about swimming; no longer prefers to lead; prefers to make technical decisions in consultation with coach; no longer always arriving early for training; no longer maintains intensity in training despite fatigue; no longer prefers coach's criticism to be offered privately; can train alone if the coach's instructions adequate; coach's criticisms no longer bother her; no longer seldom misses training due to illness; likes doing times during training to see improvement; prefers to warm-up alone prior to important race; prefers to be left alone prior to important race; can regain composure if troubled before race; likes to have races planned in detail; prefers to have race plan with options; mentally rehearses frequently prior to race; concentrates on approaching race throughout prerace period; sometimes goes out as fast as possible in first half; prefers to set her own pace; maintains race plan despite other swimmers; mainly concentrates on technique during race; times finishing sprint so that she is totally exhausted at end; able to vary areas of concentration throughout race; uses distraction techniques to alleviate feeling of pain; uses race information to modify future plans; no longer likes praise from other swimmers; no longer likes frequent coach's comments on technique; no longer likes competing with others in every repeat; no longer likes maintaining detailed records for monitoring progress; no longer likes daily feedback about rate of improvement; no longer likes public recognition through media; individual races are no longer more important than relays; despite infrequent placings, competing is enjoyable, likes to set own time goals for each meet; swimming is enjoyable in itself; ultimate goals should be set by her; displays shaking and trembling behaviours.

Table 13. Summary of Individual Behavioral Changes (continued)

F2: needs coach to direct her; no longer maintains composure when upset; unfamiliar pools now affect performance; extremely upset when things go wrong; no longer reluctant to discuss feelings about swimming; worried when others say something bad about her; makes decisions based on well thought-out reasons; no longer organizes her equipment well; no longer always confident about performing to expectations; no longer disheartened when treated badly by others; tenses when thinking about future training and competition; no longer enjoys leadership responsibilities; likes reasons for all coaching directives; prefers not to follow pool rules; no longer prefers to do things her way; no longer tries harder in next race after disappointing race; no longer prefers to lead no matter how much effort required; no longer always arriving early for training; never leaves training early; no longer prefers coach's criticism to be offered privately; no longer considers weight-watching to be important; no longer bad tempered at training when not feeling well; coach's criticisms no longer bother her; always tells the truth; always nervous and tense prior to important race; mentally rehearses frequently prior to race; no longer concentrates on moving fast and far when on blocks; during races, concentrates on how much it will hurt; never goes out as fast as possible in first half; no longer listens for gun, rather than thinking about fast movements at start; varies race plan according to other swimmers; always feels that she could have performed better; worries about anticipated pain during impending race; no longer likes praise from other swimmers; likes competing with others in every repeat; no longer likes daily feedback about rate of improvement; no longer likes knowing the time for every repeat in training; no longer likes rewards for training goals; no longer likes receiving medallions, etc. for racing; swimming is no longer enjoyable in itself; selection to club team no longer justifies training.

F3: other's poor opinion of her work upsets attitude; swimming dreams no longer upset sleep; no longer do awkward mistakes of others not upset her; no longer occasionally grouchy and wanting to work alone; upsetting circumstances affect her for a long time; no longer experiences trembling or nausea prior to important competitions; no longer moderately anxious about her swimming; reluctant to discuss feelings about swimming; no longer worried when others say something bad about her; generally polite and quiet; no longer prefers others to plan trips; no longer upset by distractions during race preparations; always produces best effort in race; enjoys leadership responsibilities; learns best from coach rather than other swimmers; no longer has difficulty in forgetting small mistakes in front of others; more effort/ intensity into competition than into training; no longer tries harder in next race after disappointing race; swimming is most important activity; prefers to lead no matter how much effort is required; no longer prefers to make technical decisions in

Table 13. Summary of Individual Behavioral Changes (continued)

consultation with coach; will spend as much time as necessary in training; attempts new stroke mechanics despite any discomfort; no longer good judge of her performance abilities; sometimes leaves training early; no longer prefers coach's criticism to be offered privately; no longer prefers to swim repeats alone; no longer seldom misses training due to illness; no longer keeps to training program as posted; no longer will miss practice for something more interesting; no longer likes doing times during training to see improvement; no longer can regain composure if troubled before race; no longer likes to have races planned in detail; during race, concentrates on how much it will hurt; prefers not to set her own pace maintains race plan despite other swimmers; no longer tries harder as fatigue builds; no longer strives for best effort despite poor race position; uses race information to modify future plans; likes to stand on victory dias after a race; no longer likes competing with others in every repeat; training sessions should always be moderately hard; likes pushing herself in every session; likes daily feedback about rate of improvement; no longer likes knowing the time for every repeat in training; no longer likes knowing progress and improvement in all aspects; no longer likes to learn as much as possible about swimming; no longer likes receiving medallions, etc. for racing; no longer is competition mainly a means of monitoring improvement; more important races are more enjoyable; no longer would train for many years to become Olympic champion; no longer likes to improve times in all events, rather than just specialty; no longer would like to qualify and go to National Championships; no longer likes to set own time goals for each meet; selection to club team no longer justifies training; swimming is her most important concern; goals of swimming are no longer to eventually be a coach; no longer displays impatient behaviours; displays shaking and trembling behaviours.

M1: frequently considers coach to be unreasonable; no feeling of ill-health or pains; maintains composure when upset; occasionally grouchy and wants to work alone; rarely affected by any swimming troubles; no longer makes sarcastic remarks to other swimmers; comes forward on social occasions for swimming; no longer cannot tolerate conceited; loud swimmers; reluctant to discuss feelings about swimming; no longer says things just as they occur to him; expects complete obedience when in charge; considers his characteristics superior to other swimmers; no longer irritated when another swimmer mad at him; no longer reacts negatively to bossy swimmers or coaches; prefers others to plan trips; upset by distractions during race preparations; no longer always produces best effort in race; annoyed when other swimmers fool around in training; maintains intensity in training despite fatigue; no longer is controlling weight not important; no longer always tells the truth; always tries his hardest at training; always nervous and tense prior to important race; no longer does

not worry about other competitors; likes to have races planned in detail; prefers to have race plan with options; no longer always feels he could have performed better; no longer able to vary areas of concentration throughout race; no longer uses distraction techniques to alleviate feeling of pain; no longer likes coach's praise about training and performing; likes frequent coach's comments on technique; training sessions should always be moderately hard; no longer does not like swimming butterfly; no longer does not like swimming breaststroke; likes pushing himself in every session; likes daily feedback about rate of improvement; likes receiving medallions, etc. for racing; likes name on public record board; no longer likes performance goal for every training repeat; every swim is seen as a challenge; selection to club team no longer justifies training; insufficient attention is paid to race preparation; displays nervous behaviours.

M3: no longer difficult to accept negative decision; unable to handle unusual circumstances; angers quickly; attempts to be conscientious; swimming dreams no longer upset sleep; unfamiliar pools do not affect performance; no longer has restless sleeps the night before competition; able to calm down quickly after upsetting circumstances; no longer moderately anxious about his swimming; no longer criticizes coaches and other swimmers; no longer reluctant to discuss feelings about swimming; no longer seeks revenge when treated unfairly; no longer prefers others to do talking and organizing; no longer disheartened when treated badly by others; no longer enjoys taking part in swim team matters; greatly irritated by small setbacks and problems; identifies others who are unjust or selfish; will not readily adopt new training ideas; will do foolhardly things for fun at meets; no longer prefers others to plan trips; no longer tenses when thinking about future training and competition; no longer can accept advice from other swimmers; learns best from coach rather than other swimmers; no longer prefers not to follow pool rules; small things no longer get on his nerves; no longer should training programs keep him busy all the time; prefers to do things his way; no longer do training efforts equal competition effort; no longer not bothered by the pre-race upsets; no longer always expects to win races; no longer talks behind the coach's back; frequent doubts and depressions about swimming; no longer tries to do everything well at training; never leaves training early; can train alone if coach's instructions adequate; frequent, unexplained changes in training weaken coach's credibility; prefers hard training sessions; likes hard, demanding training sessions; prefers to be left alone prior to important race; does not worry about other competitors; cannot regain composure if troubled before race; no longer does not need option plan in a race; no longer concentrates on approaching race throughout pre-race period; during race, no longer concentrates on how much it will hurt, no longer never goes out as fast as possible in first half; prefers to set his own pace, no longer thinks of other swimmers during race; no longer holds some effort in reserve for a fast finish; times finishing sprint so that he is totally

exhausted at end; no longer would like to "psych-out" other swimmers; worries about anticipated pain during impending race; does not know how to recover confidence; no longer likes coach's praise about training and performing; likes outside friends being interest in his swimming; no longer likes frequent coach's comments on technique; no longer does not like swimming breast-stroke; no longer likes to learn and practice all four competitive strokes; no longer likes pushing himself in every session; no longer likes knowing the time for every repeat in training; likes name on public record board, more important races are more enjoyable.

APPENDIX F

Table 14. Stress Index: Responses of F1

Date	Part A			Part B		
	a	b	c	a	b	c
Jan. 12	3	6	0	4	18	3
15	1	8	0	5	19	1
19	3	6	0	9	16	0
21		away			away	
26	1	8	0	1	24	0
29	1	7	1	2	23	0
Feb. 3	3	6	0	6	19	0
6	2	7	0	12	13	0
9	3	6	0	13	12	0
12	2	7	0	10	15	0
16	3	6	0	7	18	0
19	2	7	0	6	19	0
24	1	8	0	5	20	0
27	0	9	0	3	22	0
Mar. 3	0	9	0	2	23	0
5	1	8	0	4	21	0
9		away			away	
12		away			away	

Note. F1 was away at swim meets.

APPENDIX F

Table 15. Stress Index: Responses of F2

Date	Part A			Part B		
	a	b	c	a	b	c
Jan. 12	1	5	3	4	21	0
15	0	9	0	2	23	0
19		sick			sick	
21		sick			sick	
26	2	6	1	2	23	0
29	2	6	1	3	22	0
Feb. 3	4	5	0	6	19	0
6	2	6	1	5	20	0
9	2	7	0	8	17	0
12	2	7	0	8	17	0
16	1	8	0	7	18	0
19	1	8	0	7	18	0
24	1	8	0	5	20	0
27	0	9	0	3	22	0
Mar. 3	0	9	0	1	24	0
5	1	8	0	7	18	0
9	1			5	20	0
12	0	9	0	3	22	0

APPENDIX F

Table 16. Stress Index: Responses of F3

Date	Part A			Part B		
	a	b	c	a	b	c
Jan. 12	3	5	1	5	19	1
15	0	7	2	0	22	3
19	1	8	0	5	20	0
21	2	6	1	3	21	1
26	0	7	2	0	21	4
29	0	7	2	0	15	10
Feb. 3	1	8	0	8	17	0
6	3	6	0	13	12	0
9	1	8	0	4	21	0
12	2	6	1	5	19	1
16	3	6	0	5	20	0
19	1	6	2	4	19	2
24	3	6	0	4	21	0
27	3	6	0	5	20	0
Mar. 3		sick			sick	
5		sick			sick	
9		sick			sick	
12		sick			sick	

APPENDIX F

Table 17. Stress Index: Responses of M1

Date	Part A			Part B		
	a	b	c	a	b	c
Jan. 12	1	6	2	7	18	0
15	0	7	2	0	22	3
19	1	7	1	8	17	0
21	0	7	2	7	18	0
26	0	8	1	2	20	3
29	0	7	2	0	22	3
Feb. 3	0	9	0	6	19	0
6	0	9	0	7	17	1
9	2	7	0	10	15	0
12	1	6	2	8	17	0
16	0	7	2	6	19	0
19	1	5	2	2	22	1
24	0	8	1	2	20	3
27	1	7	1	7	18	0
Mar. 3	0	8	1	2	20	3
5	0	9	0	3	21	1
9	1	7	1	2	21	2
12	1	8	0	3	22	0

APPENDIX F

Table 18. Stress Index: Responses of M2

Date	Part A			Part B		
	a	b	c	a	b	c
Jan. 12	1	5	3	4	9	12
15	2	5	2	2	10	13
19		sick			sick	
21	0	6	3	3	12	10
26	2	3	4	2	8	15
29	2	4	3	1	9	15
Feb. 3	1	5	3	3	7	15
6	2	5	2	6	11	18
9		sick			sick	
12	2	4	3	1	9	15
16	0	8	1	0	10	15
19	3	5	1	2	9	14
24	2	5	2	3	10	12
27	1	5	3	4	11	10
Mar. 3	3	4	2	5	9	11
5	2	5	1	3	9	13
9	1	4	4	2	10	13
12	1	5	3	3	9	13

APPENDIX F

Table 19. Stress Index: Responses of M3

Date	Part A			Part B		
	a	b	c	a	b	c
Jan. 12	4	5	0	9	16	0
15	2	6	1	2	23	0
19	5	3	1	9	16	0
21	4	3	2	9	16	0
26	1	6	2	4	21	0
29	1	8	0	2	23	0
Feb. 3	3	5	1	5	20	0
6	2	7	0	5	20	0
9	2	5	2	4	21	0
12	3	6	0	7	18	0
16	1	7	1	2	23	0
19	0	8	1	4	21	0
24	2	6	1	2	23	0
27	2	5	2	5	20	0
3	1	7	1	5	20	0
5	1	8	0	2	22	1
9		sick			sick	
12	1	7	1	5	20	0