THE RESPONSE TO FRUSTRATION
OF
PHYSICALLY FIT AND UNFIT INDIVIDUALS

by

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THESIS

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ABSTRACT

Fifty-two male and 40 female undergraduates were tested for their levels of physical fitness as determined by predicted maximal oxygen uptake. By selecting the top and bottom ten subjects for each sex a fit and unfit group for both males and females was formed. All subjects were exposed to an emotionally stressful situation involving both frustration and insult. Heart rate and a "Research Evaluation Questionnaire" (REQ) were used to measure the effects of the frustration manipulation. Frustration led to elevated heart rates and generally negative responses on the REQ for all four groups. Fit subjects showed significantly ($p < .01$) greater recovery in their heart rates than the unfit subjects. The results indicate that level of physical fitness is not related to the magnitude of the emotional response to a frustrating situation, but that it is related to the speed with which heart rate returns to basal levels following emotional stress.

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INTRODUCTION

Individuals who exercise regularly and are physically active claim a general feeling of well being (Morgan 1968 and Scott 1960). Hart and Shay (1964) report a positive correlation between physical fitness level and academic performance. Cureton (1963) states that the fit person is relatively more ready for action, and has more movement in general for pleasure, business and health. Physical exercise has been prescribed for tension reduction (Van Huss, 1960 and Sessoms, 1965). Cureton (1969) states:

> In people who become progressively unfit, there is also progressive concomitant loss of ability to withstand stress. Physical training is probably the best way to train the body and the mind to resist stress, and thus retain youthfulness. (p. 30).

A number of studies have investigated the relationship between physical fitness and various aspects of emotional health with the use of psychometric tests. Brozek (1952) has reported the parallel loss of certain desirable personality traits with aging and loss of physical fitness. He compared the personalities of young men and middle age men, using an extensive psychosomatic inventory. This study revealed that personality deterioration and physical deterioration parallel each other.

Wells (1958) and Breen (1959) found low levels of

physical fitness to be correlated with characteristics such as anxiety, tension, emotionality and withdrawal in college men.

In another study Harris (1963) found a tendency for physically fit women to appear more stable in several psychological traits and appear less anxious. Seventy-nine college women were administered a three test physical fitness battery. The eighteen low scorers and eighteen high scorers made up the fit and unfit groups. Subjects in the two groups were administered the Taylor Manifest Anxiety Scale and the Edwards Personal Preference Schedule (EPPS). Several EPPS personality variables revealed significant differences. For example, the intraception variable for the fit group was significantly higher than for the unfit group. This variable purports to measure how one analyzes one's motives, observes others, and puts one self in another's place. The analysis of Taylor's Manifest Anxiety Scale showed the unfit group appearing slightly more anxious.

Tillman (1965) did a similar study with a larger sample. Three hundred and eighty-six junior and senior high school males were tested for their physical fitness. The personality tests used in this study were the A-S Reaction Study (Allport 1928), Cattell's sixteen personality factor questionnaire (16PFQ, Cattell 1962) and the Kuder Preference Record. The top 15% and bottom 15% on the physical fitness test were selected to take the personality tests.

Significant personality differences were found. The physically fit group had a significantly higher ascendance rating (a personality trait characterized by quickness and cleverness) on the A-S Reaction Study than did the unfit group. The fit group appeared more surgent on factor F of Cattell's 16PFQ (surgent meaning dominance or having leadership qualities). They also exhibited greater social dependence on Factors Q2, and Q4, indicating they were less tense than the unfit group. The groups did not differ significantly on the other factors.

Additional studies have investigated the relationship of fitness and different measures of interpersonal adjustment and effectiveness. Rarick and McKee (1949) and Smart and Smart (1963) found significant relationships between fitness and achievement in areas of popularity, leadership, happiness, dependability, freedom from tension, overall emotional adjustment, and others. More recently, several applied psychologists have begun research in the area of interpersonal effectiveness and the helping role and its relation to fitness levels. Carkhuff (1971) sees physical fitness as a prerequisite for success in the emotional, interpersonal and intellectual areas. Carkhuff, Banks, Berenson, Griffin and Hall (1971) report a significant correlation of 0.61 between fitness levels for adults and their effectiveness in helping roles.

The designs of the studies described above were correlational, subjects were just classified regarding fitness,

it was not something directly manipulated by the experimenter. Correlational designs have the limitation that causality cannot be inferred. For example, even though Carkhuff et al.(1971) found a correlation of 0.61 between fitness level and effectiveness as a helper they cannot conclude that it was only fitness which caused the helpers to be successful. There may have been, and probably were, additional factors causing subjects to be both physically fit and effective helpers. In order to evaluate causality it is necessary for the experimenter to directly manipulate the fitness levels. This can be accomplished by taking a group of subjects and randomly assigning them to two separate groups. One group undergoes an extensive training program, while the other group does not. The differences between the two groups following the training program can be attributed to the effects of training or more specifically the increased level of fitness. Even in this manipulative design, fitness may not be the only causal factor. There are many factors which only the trained group might experience, for example, an increase in self discipline, or improved body image.

There are several reasons why many experiments use the correlational approach rather than the experimental or manipulative approach in research involving physical fitness. First, it is easier to apply, less expensive and less time consuming. To acquire the fitness level difference of the

two groups necessary to evaluate the effects of physical fitness, an extensive, time consuming training program is necessary. For example, Gutin (1966) cited below (p. 12), suggests his insignificant results may have been due to too small a fitness level difference, making a longer more extensive training period necessary for future research (he trained his experimental group for a 12 week period). Second, in many instances it is not necessary to have causality information. In prediction and selection problems it is sufficient to know that two factors are correlated. For example, the correlation of 0.61 between fitness and effective helping reported by Carkhuff et al. (1971), is of potential importance for selecting helpers. Given that other valid selection criteria were held relatively constant, choosing potentially effective helpers using fitness as a criterion would lead to more success than just doing so on a random basis. Thirdly, correlational studies offer a useful preliminary test to show the potential direction for further research. Following this line of thought the present study is designed to provide preliminary information on whether fitness may be related to the response to emotional stress.

So far, this review has provided various data suggesting the psychological benefits of fitness. Basically, these data suggest that being physically fit is conducive to having

seemingly positive psychological characteristics such as a general feeling of well being, having positive personality traits, and being interpersonally effective. Data regarding how fit and unfit people may differ regarding their reactions to various psychological situations could potentially add to our understanding of the relationship between fitness and psychological factors. But no research of this type has been done. Fit people have been reported to be more emotionally stable, less anxious etc., but no information is available on how their responses may differ to a particular emotionally stressful situation. Do fit individuals experience less anger, less anxiety or less arousal than unfit individuals in the same stressful situation? The present study is concerned with investigating this question in the context of a frustrating situation. Before examining this question further, it is important to clarify what is meant by physical fitness, to examine research comparing the responses of fit and unfit people to physically stressful situations and to review studies that involve the measurement of responses to frustrating situations.

Physical Fitness

Physical educators have developed a variety of test batteries for fitness which include such test items as running, jumping, throwing, pull ups, push ups, etc. These test batteries of motor fitness attempt to measure such elements

of physical fitness as degree of muscular development, strength, speed, agility, endurance, power, coordination, balance, flexibility and body control. For example, the Army Air Force Physical Fitness Test was one of the first motor fitness tests and included three test items, sit ups, pull ups and 300 yard shuttle run. Larson (1946) indicates that these three items were found to correlate closely (r = 0.86) with an entire battery of items which include all motor performance elements. The Indiana Motor Fitness Indices, the California Physical Performance Test, and the AAHPER Youth Fitness Test Battery are examples of some of the more recent motor fitness tests (Cooper 1968).

Recently there has been an increasing recognition that cardiorespiratory, aerobic or endurance fitness may be one of the most important indices of total physical fitness. Several measurements of cardiorespiratory fitness have been devised over the years. An example is the Harvard Step test in which a subject steps up and down so many times per minute on a 20 inch step. When finished with this procedure, recovery heart rate is taken at different intervals. Norms for heart rate recovery have been established for this test for comparing fitness levels.

Many researchers are now using maximum oxygen uptake (MVO_2) to measure cardiorespiratory fitness (Taylor and Buskirk, 1955; Balke, 1963; Cooper, 1972; and Astrand

and Rodahl, 1970). MVO_2 is a measure of the volume of oxygen consumed when working at maximum capacity. It is a measure of the amount of oxygen the cardiorespiratory system is capable of extracting from air when working at maximal capacity. MVO_2 is measured in liters of oxygen consumed per minute. But, when using this measure as a measure of fitness the liters of oxygen consumed per minute are expressed relative to body weight since large people obviously require more oxygen than small people and obese people require more oxygen than nonobese people. The units conventionally used for measuring MVO_2 relative to body weight are millimeters of oxygen consumed per kilogram of body weight per minute (ml/kg/min). Presently, MVO_2 is usually measured while performing on a bicycle ergometer which is a stationary bicycle on which an individual pedals against an adjusted work load. It can also be measured while performing on a treadmill or in a variety of other situations. The usual method for the determination of oxygen uptake is the Douglas bag method. It is well tested under a wide variety of circumstances (Astrand and Rodahl, 1970). In this procedure the O_2 consumption is directly measured from the O_2 level of the expired air when working at maximal levels. The volume of expired air is measured in a balance spirometer and the composition of the air is analyzed by electronic gas analyzers and the MVO_2 in liters/min. is determined.

Rowell, Taylor and Yang Wang (1964) state that MVO_2 is a useful criterion for assessing the overall capacity of an individual to perform aerobic work. An individual's MVO_2 is ultimately dependent upon his capacity to supply oxygen to the working muscles. Taylor (1955) states that when the measurement is obtained under properly standardized conditions it has been shown to be a highly reproducible characteristic of the individual having a coefficient of reliability of 0.95. Reliability coefficients for this test above 0.95 have also been found by Buskirk (1957) and Metz (1967). The most important drawback of this test is that the determination of MVO_2 is a time-consuming procedure for both subjects and researchers and for this reason it is not commonly employed in the study of large groups of subjects. Moreover, researchers are hesitant to work subjects to exhaustion especially without prior medical clearance.

In order to encourage wider application of the concept, Astrand and Rhyming (1954) have developed a procedure for predicting MVO_2 from performance at submaximal workloads. Since the volume of oxygen consumed (VO_2) and heart rate are linearly related over a wide range of values, Berggren and Christensen (1950) postulated that the MVO_2 could be predicted by extrapolation of the slope of submaximal VO_2 versus heart rate values to an assumed maximal heart rate. P. O. Astrand (1954) and I. Astrand (1960) have constructed and revised

respectively a nomogram (table) which rests upon the above postulate. This nomogram in tests using the bicycle ergometer enables a prediction of MVO_2 to be obtained from a stable heart rate that a subject displays while working at a constant workload.

The results on which the nomogram is mainly based includes values obtained on 31 female and 27 male well-trained subjects 20 to 30 years of age, whose actual MVO_2 was determined in maximal tests on the treadmill or bicycle ergometer. The submaximal or predicted MVO_2 test was administered on the bicycle ergometer (Astrand and Ryhming, 1954). For two-thirds of the subjects the difference between actual and predicted MVO_2 was less than 6.7 per cent for men and 9.4 per cent for women. A second control for validity of the nomogram was obtained on 18 males 18 to 19 years of age. The difference between the calculated and determined MVO_2 was less than 7 per cent on the average. It should be emphasized that the nomogram is based on results from experiments with healthy subjects 18 to 30 years of age. The validity of the nomogram has been tested in other laboratories; there has been good agreement between the maximal oxygen uptake predicted from the nomogram and the actual value. Glassford, Baycroft, Sedgwich and MacNab (1965) compared the values obtained from actual and predicted MVO_2 tests. A correlation coefficient of 0.83 was found.

Teraslinna, Ismail and MacLeod (1966) found a correlation coefficient of 0.69 which is in close agreement to I. Astrand's (1960) earlier correlation coefficient of 0.71. Astrand and Rodahl (1970) stated that the predicted submaximal fitness test can be applied as a valuable screening test. They also said it is a useful method for selecting out the best, the worst and the average fit men and women from a group. Astrand (1973) suggests repeated submaximal tests on the bicycle ergometer are very useful for measuring the effectiveness of a physical training program. Glassford et al.(1965) concluded that the Astrand-Rhyming nomogram produces a good estimation of actual MVO_2, even in a population unaccustomed to cycling.

Fitness and Physical Stress

A number of studies have examined the relationship between physical fitness and mental functioning under physical stress (see Weingarten, 1973 for a review). Weingarten (1970a) measured abstract reasoning while the subjects were being physically exerted. A maximum oxygen uptake test was administered to subjects to determine their level of fitness and comparisons were made between 13 fit subjects and 9 less fit subjects. The abstract reasoning tasks were administered before and during physical exertion. In the pre-exertion task the fit group performed slightly but not significantly better ($p < .10$). In the second abstract

reasoning task under severe physical stress the fit group scored significantly better than the less fit group ($p < .01$). The fit group also equalled their pre-test performance.

Hammerton and Tickner (1968) studied the effect of vigorous physical stress administered before the performance of skilled tasks of moderate and great difficulty, on extremely fit British soldiers and soldiers of normal level fitness (i.e. less fit). Following the physical stress, the less fit subjects showed no decrement on the moderately difficult task, but a considerable decrement on the task of great difficulty. The extremely fit subjects showed no performance decrement on either task.

Gutin (1966) tested the hypothesis that an increase in physical fitness level has a positive effect on the ability of an individual to perform mental tasks following physical stress. He divided 55 male subjects into two groups, elevated the fitness level of one group through a program of exercise and administered a series of mental tasks to both groups following a moderate physical stress period. Results showed that fit subjects performed better than the unfit subjects on the mental task following stress, although the difference did not quite reach significance. Gutin suggests that too mild a stress period and too small a fitness level difference between the groups contaminated his results.

Gutin and DeGennaro (1968a, 1968b) demonstrated that

physically fit individuals could consistently, but not significantly, out perform less fit individuals on mental tasks performed following the termination of physical stress.

Weingarten (1970b) performed another study where the main purpose was to see if the ability to perform mental tasks during severe physical exertion improved as a result of an increase in physical fitness. Again, the cardiorespiratory fitness was measured by MVO_2 and again abstract reasoning tests were used for pre and post mental tasks. Based on the pre-physical fitness information and the pre-mental test scores under stress, the 30 subjects were assigned to two matched groups. The experimental group underwent a conditioning period of 7 weeks; the control group were not trained. There were no between group differences on any of the pre-test variables, but several differences on the post-test. The cardiorespiratory fitness of the fit group was significantly higher ($p < .001$) and the post-mental test performance of the fit group was significantly higher ($p < .01$). A comparison of heart rates after the conditioning period showed the unfit group having faster heart rates during the exercise with the fit group having the identical heart rate on both exericse tasks.

In summary, physically fit compared to unfit individuals seem to perform better on a variety of tasks under conditions of physical stress. The usual interpretation of these results (eg. Weingarten 1973) is that fit people are

able to maintain their level of arousal at a lower level under physical stress than the level of arousal reached by unfit individuals. Because of the inverted U shaped relationship between performance under physical stress situations and level of arousal (eg. Duffy, 1962) the fit people perform better on complex tasks such as abstract reasoning. There are, however, no studies which have compared responses of fit and unfit individuals under conditions of psychological stress.

Frustration

Frustration can be defined generally in terms of interference with an ongoing goal directed response or activity. Varying conditions of frustration can be operationally defined by experimental manipulations. The effects of frustration in terms of the degree of emotional arousal or stress depend on a variety of factors. Frustrating situations become intensified if the thwarting includes insult, attack, lowering of self esteem, etc.

Feshbach (1955, 1961) used insult or critical remarks alone to arouse his subjects. The relative effects of frustration and insult conditions have been compared in only a few studies. Geen and Berkowitz (1967) found that task frustrated subjects who saw a violent movie were more aggressive than control subjects and less aggressive than insulted subjects. Geen (1968) examined separately the effects of frustration. Geen exposed subjects in three

experimental groups to insult frustration (unprovoked verbal assault from a confederate), personal frustration (the confederate prevented the subjects from completing an assigned task, and task frustration (subjects were administered an unsoluable task). Results indicated that insult was the most effective, followed by personal and task frustration. Apparently verbal provocation was a more effective elicitor of a subject's response than were the other two forms of frustration. Similar results have also been reported by Gentry (1970) and Rule and Hewitt (1971). Other investigators have experimentally induced frustration by blocking goal attainment (Burnstein and Worchel, 1962 and Speigel and Zelin, 1973). The frustration of insoluble tasks was used by Geen and Berkowitz (1967). Doob and Kirshenbaum (1973) induced frustration by having the experimenter interfere with the completion of a reinforced task.

Different investigators have used various methods of measuring responses to frustration. Geen and Berkowitz (1967) used three measures for obtaining the responses to frustration. The measurements used were a simple adjective check list, i.e. mood questionnaire, a self-report and the Buss aggression machine (Buss, 1961). This machine measures the intensity and duration of shocks administered to a frustrating person, who is usually a confederate of the experimenter. The Buss-Durkee Hostility Inventory has also been widely used (Buss, 1961). Most of these dependent

measures check for responses of anger or aggression towards the experiment, the experimenter, or a confederate.

Feshbach (1955) formulated an attitude questionnaire as an implicit and direct measure of the effects of frustration toward the experiment and the experimenter. He postulated that if the insulting, frustrating attitude of the experimenter had the intended frustrating effect toward him or the experiment then this effect should be reflected by the angry response of the insulted, frustrated subjects on the questionnaire. Results from Feshbach's work (Feshbach 1955, 1961) have shown his questionnaire to be a sensitive psychological measure of the effects of frustration. Fishman (1965) used a modified form of this measurement naming it the "Research Evaluation Questionnaire." He administered it following a frustration manipulation and showed it to be a sensitive measure of frustration. Other investigators have used similar questionnaires for the measurement of the effects of a frustrating situation (Hokanson and Burgess, 1962; Kregarman and Worchel, 1961). These studies support the value of using a questionnaire as a dependent measure in investigations involving the effects of frustration.

Hokanson (1969) and Hokanson and Burgess (1962; 1964) have demonstrated that a condition involving frustration, harrassment, and failure increased physiological activation as measured by blood pressure. More recently,

Gentry (1970) examined the effects of frustration (test failure) and attack (experimenter insult) on systolic and diastolic blood pressure. Insult combined with frustration led to more of an increase in blood pressure than did no insult or frustration. Similar results have also been reported in other studies (Fishman, 1965; Speigel and Zelin, 1973; and Doob and Kirshenbaum, 1973).

Weybrew (1967) reviewed the literature on psychophysiological responses. It is clear from this review that the responses of blood pressure and heart rate to a psychologically stressful situation, e.g. threat to status or self esteem, are virtually identical. Rule and Hewitt (1971) recently examined the effects on heart rate of three thwarting conditions; two involving frustration and one involving frustration plus insult. They found that frustration plus insult (high thwarting) with an opportunity to retaliate led to an increase in both heart rate and aggressive responses. These studies support the value of using heart rate as a dependent measure in investigations concerned with the measurement of the effects of frustration.

The Present Study

It should be emphasized that the review of the literature examining physical stress concentrated on performance variables (e.g. mental arithmetic tasks). In contrast the focus of research involving emotional stress,

such as the present study, is not on performance variables, but on the assessment of the level of emotional arousal. The review of these studies utilizing performance variables was included because of the apparent similarity of the paradigms. Even though this similarity exists, the aims of the present study are quite different from those of studies involving physical stress. The effects of stress on performance variables are known to follow an inverted U-shaped function. Work on the inverted U relationship between behavioral efficiency and level of arousal was initiated by the now classical work of Yerkes and Dodson (1908). This work has demonstrated that at a moderate degree of arousal behavioral efficiency is optimal (Duffy, 1962). Hokanson (1969) presented data showing that stress produces an inverted U effect on performance but a linear effect on heart rate. Presumably, dependent measures such as heart rate and psychometric scores or self-reports increase proportionately to the degree of emotional stress and are reasonably direct measures of the level of emotional arousal.

While physical fitness has been shown to affect the performance on a mental task under physically stressful conditions, stress in the form of frustration has not been investigated. The purpose of this study was to examine the effects of the frustrating situation on physically fit (high predicted MVO_2 score) and unfit (low predicted MVO_2 score) individuals. It was expected that physically fit

subjects would be less volatile than the unfit and would recover from the frustration quicker than the unfit subjects. This hypothesis was based on the evidence presented indicating that fitness is conducive to having positive psychological characteristics. The present study compared the responses of fit and unfit individuals to a situation involving both frustration and insult. More specifically, subjects were first screened as to their predicted MVO_2. Secondly, subjects were administered three I.Q. subtests given to deceive them of the true nature of the experiment. Then, a Stroop task was administered while the experimenter thwarted and insulted the subject to produce a frustrating, stressful situation. The effects of the treatment were measured by heart rate and a modified form of Fishman's (1965) "Research Evaluation Questionnaire."

METHOD

This experiment consisted of two parts. Part one dealt with the determination of the subjects' levels of fitness. In part two, the subjects took part in a psychological experiment where they were frustrated. The two parts of this procedure were carried out in separate facilities at the University by different people, as described below.

Part I

Subjects

Ninety-two undergraduate university students were

recruited from introductory psychology classes. Fifty-two male and 40 female students were tested for their levels of fitness. Course credit was given to subjects for their participation.

Apparatus

The fitness test was performed on a bicycle ergometer manufactured by Monark, Varberg, Sweden. The bicycle ergometer's range for workloads was from zero to 1500 kilopond meters per minute (kpm/min). One kilopond is the force acting on the mass of one kilogram at the normal acceleration of gravity. The distance travelled by each revolution of the pedal was 6 meters.

Procedure

The subjects arrived four at a time at the Physical Education Human Performance Laboratory. They changed to gym strip or wore non-restrictive clothing during the fitness test. The procedure used was virtually identical to the one described by Astrand and Rodahl (1970). That is, subjects worked for at least 6 continuous minutes on a bicycle ergometer at submaximal workloads in order to achieve a steady state working heart rate. From the steady state heart rate at a given work load one can predict the MVO_2 by using the Astrand Rhyming nomogram (Astrand and Rodahl, 1970).

First, sex, age and weight were recorded. Following this the subjects were instructed to take a seat on the bicycle

ergometer. Experience has shown (Astrand and Rodahl, 1970) that the resting heart rate does not normally give any information over and above that provided by the work test and it was not recorded. The bicycle seat was adjusted to a comfortable position with full leg extension for the subject. Two technicians under the supervision of an exercise physiologist then ran the subjects through the following procedure. Subjects were instructed to pedal in time to a metronome. The metronome was set at 100 beats per minute which results in the subject pedalling at 50 revolutions per minute (rpm). The participants started pedalling for 10 - 15 seconds with no resistance or workload to give them a chance to familiarize themselves with pedalling to a metronome. After this brief period of practice the subjects then pedalled in time to the metronome while the assistants increased the tension on the wheel of the bicycle ergometer. The first workload was then applied by the assistant. The assistant used varied workloads, 150, 300, 450, and 600 kpm/min. For example, the tension on the bicycle ergometer might be at one kilopond (kp). Since all subjects pedalled at 50 rpm and since the equivalent in distance travelled by the flywheel for each revolution of the pedal was 6 meters, the subject would pedal the equivalent of 300 meters per minute i.e. 50 rpm x 6 meters per pedal revolution = 300 meters per minute. If the tension on the bicycle ergometer was set at one kp they were working at the

rate of 300 kpm/min, i.e. (1 kp) (300 meters/min) = 300 kpm/min. The assistant began by using a workload he thought was sufficient to elevate the subject's heart rate above 130 beats per minute (bpm) between the fifth and sixth minute of pedalling. Heart rate was monitored every minute, and was measured by palpation of the carotid artery for 10 seconds. This number was multiplied by six to give the heart rate in bpm. If heart rate during the fifth and sixth minutes was steady (within five bpm) it was used to predict the MVO_2 at that workload. All subjects were run for 12 minutes just in case their heart rates were not at a steady state during the fifth and sixth minute. In addition, the tension was increased if the heart rate was too low. The heart rate between the eleventh and twelfth minute could be used for prediction providing the heart rate was steady and above 130 bpm during this time.

For example, suppose a female's heart rate was at a steady state of 135 bpm with a workload of 300 kpm/min. Then from Table A-3 (Astrand and Rodahl, 1970, p. 619) we would predict this subject's MVO_2 to be 2.0 liters/min. Now suppose this subject's weight was 130 pounds (59 kg). To make her predicted MVO_2 score relative to body weight we would use Table A-6. (Astrand and Rodahl, 1970, p. 620). For a person with a predicted MVO_2 of 2.0 liters/min and a body weight of 59 kg. the table indicates that her predicted MVO_2 score relative to her body weight is 34 ml/kg/min. It should be noted that a correction factor for age was used in obtaining

the predicted MVO_2 score (Astrand and Rodahl, 1970, pp.354-5).

The subjects then went through a cooling off period with no resistance until their heart rates decreased significantly. The subjects left and were not told of their results.

Reliability and validity coefficients are not available for Dr. Lavoie's laboratory. However, since the technicians were trained to administer the predicted MVO_2 test using Astrand's standardized procedure, their predictions are likely of comparable reliability and validity as those obtained elsewhere using virtually identical procedures.

Part II

Subjects

Seventy of the 92 subjects in Part I were used. Forty-one males and 29 females were contacted by phone and given appointments with the experimenter. Data from the other 22 subjects were not gathered for various reasons. Twelve could not be contacted, five were over the set age limit of 29, two were color blind and could not perform the Stroop task which deals with distinguishing colors and was used in Part II, two would not complete the second half of the experiment, and one was not naive to the experiment.

Apparatus and Stimulus Materials

The IQ Test consisted of three modified sub-tests of the Wechsler Adult Intelligence Scale (WAIS) (Wechsler,

Psychological Corp., 1955) (See Appendix A). The modified subtests were constructed as follows. The comprehension subtest was used, starting with item seven through fourteen. The arithmetic subtest was used starting with item seven ending with item fourteen. The information subtest was used, items ten through item twenty-nine.

The Stroop test (Stroop, 1935) consisted of the names of six colors (yellow, red, blue, green, brown and orange) printed in one of five colors of ink (red, blue, green, yellow and brown). There were eight pages each of 20 items; the items were randomly selected and counterbalanced.

The experimental room was equipped with a heart-rate recording polygraph (Gilson, Model M5P) which was shielded from the subject's view by a set of upright shelves. Heart-rate was recorded from the index finger of the nonpreferred hand with a finger pick-up transducer Model FP-6.

A Research Evaluation Questionnaire (REQ) along with a letter of instruction from a confederate research supervisor was used to measure anger directed toward the experimenter or at the experiment. A copy of this letter of instruction and the complete REQ are presented in Appendix B.

Procedure

All subjects were exposed to the same procedure and the experimenter was blind to the subject's fitness score.

Individuals were given an appointment by phone and were administered the second part of the experiment one at a time. The subjects were asked their age and whether they were color blind. If they were over twenty-nine years old or color blind the experiment was discontinued. If not they were shown the polygraph and told that their heart rate was going to be recorded during the course of the experiment. The subject was asked to sit down at the table and the pick-up transducer was attached and adjusted to obtain a satisfactory heart rate recording. Heart rate was recorded continuously from this point on. All subjects were blind to the true purpose of the experiment. Subjects were given the following general instructions:

> The purpose of this experiment is to investigate the relationship between physical fitness, intelligence and heart rate. You will rest and relax for about 5 minutes. You will then go through a number of different intellectual tasks. Heart rate will be recorded throughout the experiment. Do not remove the pulse indicator. I will remove it when I feel I have all the heart rate information required. Before you leave, my research supervisor has left a letter for you which he says has questions for you to fill out. You will do this after the tasks. Any questions?

As can be seen from the instructions above a false topic "Relationship between Physical Fitness, Intelligence and Heart Rate" was used. During these initial instructions the experimenter pointed to a small box containing envelopes

with the REQ and the cover letter when informing the subject of this task. Following the instructions the subjects were asked to relax for five minutes. Resting heart rate was measured as the number of heart beats in the last minute of relaxation. Subjects were then administered the three I.Q. subtests. These subtests were given to the subjects to emphasize the false topic as well as to permit a comparison of heart rates during a mildly stressful test for the fit and unfit groups. The IQ test instructions were as follows:

For Subtest One, Comprehension;

> You will now go through and answer verbally some general understanding or comprehension items.

Questions seven through fourteen were then asked.

Subtest Two, Arithmetic;

> The next set of questions will be quantitative in nature. Ready!

Items seven through fourteen were administered. For Subtest Three, General Information, the instructions were as follows;

> You will now go through and answer some very general, information questions.

Items ten through twenty-nine were given.

No matter how the subject fared in this task the experimenter made the following statement;

> I'm very surprised by how poorly you've done. I didn't expect this because 95% of people doing these tasks were able to accomplish them without error.

This began the more stressful or frustrating period. All subjects were next administered the Stroop task. Subjects were instructed as follows;

> I must emphasize try as hard as you can on this next task. Pull the folder down in front of you and open to the sample page. When you are ready you will turn the page and a list of items such as the following sample will be exposed. (Experimenter points to first sample and says, 'the first example is the color word blue written in the color ink red').
>
> Your task is to look at each item and say out loud the correct color of ink. In the first example, the correct response is 'red'. Do you understand the task? Read through the rest of the examples so I know you do.
>
> You are to go through the list as quickly as you can. You may correct mistakes but say only the correct color of ink. You should be able to finish easily in the time allotted, which is four minutes, but you must work as quickly as you can and give maximum effort and concentration correcting all mistakes.
>
> Turn the page when you are ready to begin.

It was actually impossible for subjects to complete the task in four minutes. The semantic cue of the color word is much more salient than the color cue. In addition to this frustration inherent in the task itself, the experimenter engaged in certain behaviors designed to produce additional frustration. The experimenter first allowed the subject to

go through two cards or 40 items undisturbed and then stopped him abruptly and said,

> You are not concentrating, I told you, you have to try as hard as you can. You're wasting my time by thinking this is a game. This is an experiment. Start over. Begin.

The experimenter then allowed the subject to complete four cards and stopped him again, looked at the subject disgustedly and said,

> What are you trying to do, ruin my experiment? How simple is it to read off colors of ink? Now listen! You have to concentrate, this is the last chance I'm going to give you to finish the 8 cards in the time limit. It might help if you sit up. Come on, sit up! Ready, begin.

The subject then went through two cards and the experimenter said "pick it up"--after the fourth card experimenter exclaimed, "correct your mistakes, come on pick it up." The subject was stopped at the sixth card and the experimenter said,

> That does it, you've failed to make it in the time limit. 95% were able to complete this easily. Remember I said it was important that you do your best, that you make some kind of effort. You didn't care about the whole thing because if you did you would have made it. Don't forget to answer that letter. I'll be back in a few minutes to unhook you.

The experimenter then left the room, slamming the door behind

him, and returned in five minutes. The pick-up transducer was then removed from the subject's finger and a letter of explanation was given to the subject to read (See Appendix C). After reading this letter all subjects were interviewed and debriefed. The interview was conducted to see if the frustration treatment was successful and to elicit other information. The following question format was followed for all subjects;

(1) Were you ever frustrated at me during this experiment?

(2) Were you ever frustrated at yourself during this experiment?

(3) Did you read into the questionnaire?

The subjects were then debriefed. Debriefing included review of the complete nature of the experiment and explanations and reasons for the use of frustration, stress, insult, etc. The following questions were then asked;

(1) What was this experiment really about?

(2) Did you hear anything about this experiment before?

(3) Do you have any ideas or suggestions?

(4) Did you really feel angry or frustrated at me?

The subjects were also told that they could not be in the experiment again, that they would be credited two hours for their participation and that they should please keep the experiment confidential or there would be a possible

waste of both experimenter's and subject's time.

A debriefing check was made by the subject's reply to three questions.

(1) If you were going to be in another experiment would you like to serve or volunteer with me as the experimenter?

(2) Do you feel badly about any part of the experiment?

(3) Was the experiment worthwhile for you?

Subjects were thanked for their participation in the experiment and told they would be contacted as to the results of both parts of the experiment.

Data Analysis

Heart rate data from four periods during the experiment were examined:

(1) (resting heart rate) the last minute of the five minute relaxation period,

(2) the last minute of intelligence testing (I.Q. heart rate),

(3) the last minute of the thwarting period or the Stroop task (stress heart rate) and

(4) the last minute of the five minute recovery period (recovery heart rate).

The REQ was scored by summing algebraically the individual's scores on the seven items with a possible range from -35 to +35 for each individual. Thus a low score

indicated that a subject was negative toward the experimenter or experiment, while a high score indicated positive feelings.

Although the design of the present experiment was correlational, it was decided, a priori, that fitness level i.e. predicted MVO_2 score would be treated as an independent variable and that subjects in the top and bottom quartiles of fitness level would constitute fit and unfit groups. The original design of this study called for 120 subjects, 60 males and 60 females. By selecting the top and bottom quartiles for the division of fitness levels for both male and female groups four groups each of 15 subjects would be obtained. Data collection was terminated because of difficulty in obtaining subjects; only 41 males and 29 females could be obtained for participation in both parts of the experiment. At this time, before any of the data were examined, a decision was made to use the top and bottom 10 subjects for both male and female fitness level divisions. Rather fortuitously, in view of the smaller size of the female sample, the separation of the fitness scores for the fit and unfit groups were comparable for both males and females.

By selecting the top and bottom ten subjects on the basis of their predicted MVO_2 scores fit and unfit groups were formed for both male and female subjects. The four groups were;

(1) unfit male (UM)

(2) unfit female (UF)

(3) fit male (FM) and

(4) fit female (FF).

The primary data analyses were 2 x 2 analyses of variance performed on these four groups. In addition, correlations were calculated between MVO_2, REQ, basal heart rate, I.Q. heart rate change, stress heart rate change and recovery heart rate change over all 70 subjects. While the correlational analysis generally is less powerful than an analysis of extreme scores, it has the advantage that the scores for all subjects are included in the analysis. Moreover, both analyses test essentially the same hypotheses.

RESULTS

Predicted Maximal Oxygen Uptake Scores

The predicted MVO_2 scores are presented in Table 1 and covered a wide range for both males and females. Mean age and age range for male and female subjects are also presented in Table 1. In spite of the smaller number of females the range of predicted MVO_2 scores for the fit and unfit groups are similar for both males and females and are presented in Table II.

The mean predicted MVO_2 scores for the fit and unfit groups are comparable to the scores for fit and unfit men and women in Sweden and the U.S.A. For U.S.A. men under thirty, less than 33.7 ml/kg/min. is poor and above 42.6

ml/kg/min. is good to excellent, (Cooper, 1972). For Swedish women, less than 34.0 ml/kg/min. is somewhat low and 44.0 ml/kg/min. and above is high (Astrand and Rodahl, 1970).

An analysis of variance of the predicted MVO_2 scores revealed a high significant difference between the predicted MVO_2 scores of the fit and unfit groups ($F = 265.19$ df = 1,36; $p < .001$). This independent variable classification check was done simply to confirm that the groups were in fact different. The difference between males and females was significant ($F = 5.518$, df = 1,36; $p < .05$). This finding indicates that the females were more fit than the males. There was no interaction effect between sex and fitness ($F < 1.0$, df = 1,36).

Heart Rate

Figure 1 shows the mean heart rates for the four groups at each of the four phases of the experiment. The basal heart rates of the fit subjects were significantly lower than those of the unfit group ($F = 17.13$, df = 1,36; $p < .01$). The basal heart rates were lower for male subjects than for females and this difference approaches significance ($F = 3.85$; df = 1,36; $p < .10$). Because of these differences in basal heart rates, heart rate change scores (i.e. from basal level) were compared for the other three phases of the experiment. Heart rate change scores are

TABLE I

PREDICTED MVO_2 SCORES FOR MALE AND FEMALES

	Predicted MVO_2 (ml/kg/min)			Age (Years)	
	N	Mean	Range	Mean	Range
Male	41	36.07	23 - 53	19.71	18 - 23
Female	29	39.03	23 - 58	20.17	18 - 26

TABLE II

MEAN PREDICTED MVO_2 SCORES FOR FIT AND UNFIT GROUPS

Predicted MVO_2 scores, (ml/kg/min)

	Fit			Unfit		
	N	Mean	Range	N	Mean	Range
Male	10	46.4	40 - 53	10	26.6	23 - 32
Female	10	50.0	43 - 58	10	28.9	23 - 34

frequently used in analyzing heart rate data to eliminate variability due to differences in base rates (e.g. Evans, 1972, 1974).

The mean differences and significance levels of t tests for the heart rate change from basal to I.Q. testing, basal to stress and recovery to basal are displayed in Table III. These data show that heart rate increased significantly during I.Q. testing and stress for each group. The heart rates after the recovery period were still significantly elevated except for the fit female group.

The changes in heart rate from basal to I.Q. testing did not differ significantly between groups ($F < 1.0$, df = 1,36). This finding indicates that the mild stress of I.Q. testing produced similar increases in heart rate for all groups. Figure 1 displays these results.

The changes in heart rate from basal to stress did not differ significantly between groups ($F < 1.0$; df = 1,36). This finding implies that the frustration or stressful Stroop test and accompanying manipulations produced similar effects on heart rate for all groups.

The differences between the levels of heart rate after five minutes of recovery and the basal levels differed significantly between the fitness conditions ($F = 19.13$, df = 1,36; $p < .001$). There was no sex difference ($F < 1.0$, df = 1,36). As can be seen from Figure 1, the fit subjects, both male and female, returned to near baseline levels during the

TABLE III

CHANGES IN HEART RATE (COMPARED TO BASAL LEVELS)

	IQ Change		Stress Change		Recovery Change	
	$\bar{X}$	t	$\bar{X}$	t	$\bar{X}$	t
FF	6.3	6.42***	33.6	5.52***	2.8	1.34
FM	8.0	2.92*	33.9	6.05***	7.9	3.85**
UF	6.3	2.35*	36.7	8.42***	17.2	7.87***
UM	8.9	6.88***	31.3	8.29***	11.8	7.69***

* .05

** .01

*** .001

recovery period, while the heart rates of the unfit subjects remained elevated. The mean heart rate after the recovery period for the unfit males was 11.8 above their resting heart rate, while for the unfit females the mean was 17.2 above their resting heart rate. In contrast the fit males remained 7.9 beats above their resting heart rate while the females remained only 2.8 above their resting heart rate. There was also a significant interaction between sex and fitness ($F = 6.30$, $df = 1,36$; $p < .05$)

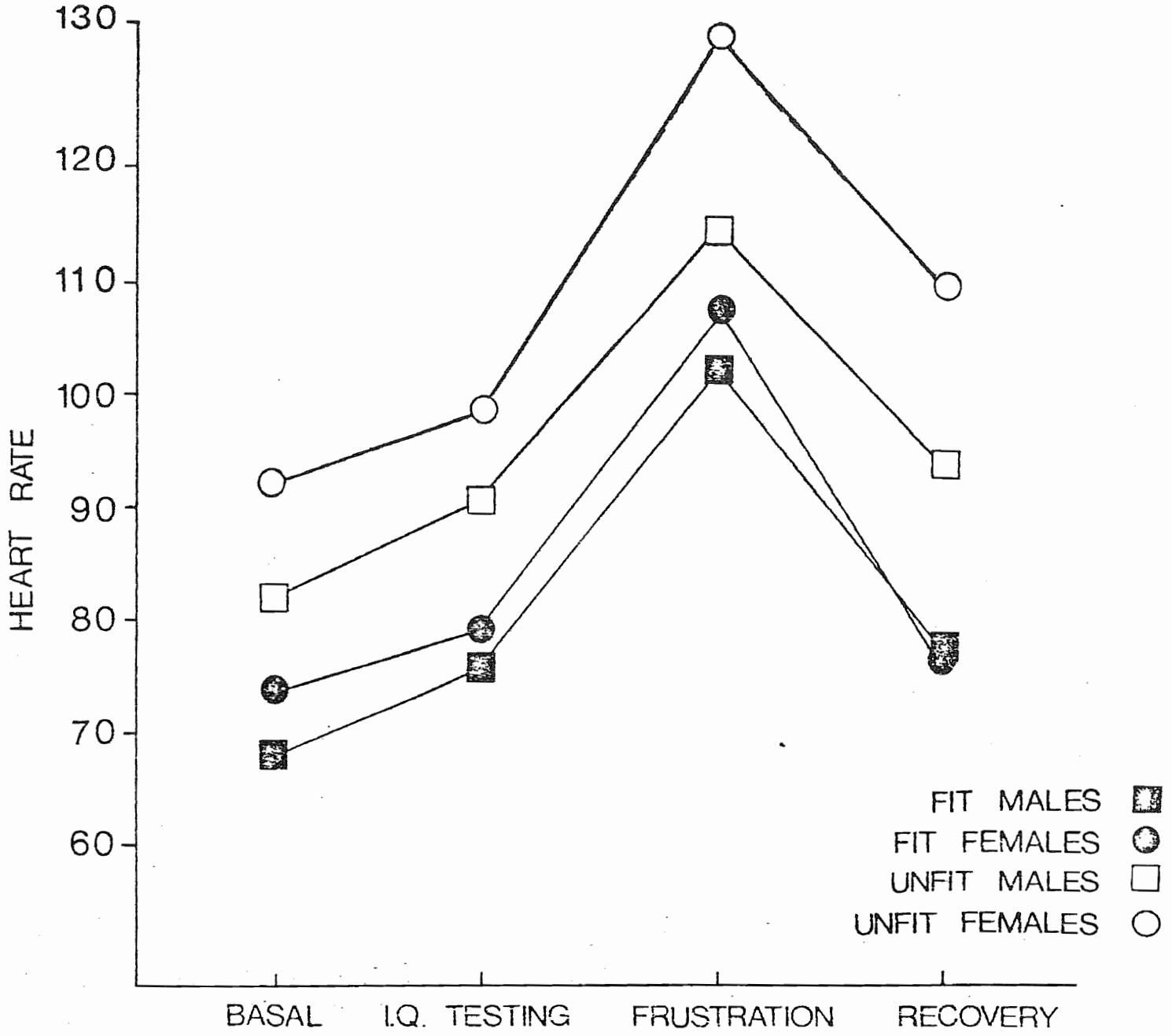


Fig. 1. Mean heart rates at each of the four phases of the experiment over all groups.

which reflects the greater difference between the recovery of the fit and unfit females than between the fit and unfit males.

Research Evaluation Questionnaire (REQ)

The REQ was answered in a similar manner by all subjects. An analysis of variance across all four groups revealed no significant differences. The analysis did not indicate any significance for the differences between fit and unfit subjects ($F = 1.54$, $df = 1,36$; N.S.), between males and females ($F = 2.38$, $df = 1,36$; N.S.), or for the interaction ($F = 3.33$, $df = 1,36$; N.S.). The mean overall rating was -1.85 indicating a generally negative view of the experiment and the experimenter. Means for fit and unfit males and females are presented in Table IV.

An item analysis was done for each individual question for each group. Mean response scores for the four groups on individual questions and their correlation to the total score are presented in Table V. It shows the REQ to be internally consistent.

Post Experiment Interview or Self Report

All subjects reported the treatment (i.e. frustration, insult) successful. Thirty-eight of the 40 subjects expressed that they were frustrated by the experimenter and 14 of the subjects reported that they were both frustrated by the experimenter and at themselves. Eleven of the 40

TABLE IV

REQ MEAN SCORES ACROSS FOUR GROUPS

	Fit		Unfit	
Male	N = 10	-5.1	N = 10	8.0
Female	N = 10	-3.9	N = 10	-6.4

subjects reported that they read into the REQ, i.e. they suspected that the experiment was really concerned with frustration. The responses of the groups to questions asked during the interview are presented in Table VI. The response to question three displayed in Table VI reveals that the same group (UM) which read into the questionnaire also gave the most positive REQ responses (refer to Table V). This raises the possibility that the responses to the questionnaire (REQ) by the unfit male group are contaminated. As support for this, the REQ mean ratings for the 8 subjects who read into the REQ was noted to be 11.1, compared to the mean of -4.5 for the two who did not read into the REQ. The difference between these means suggests that subjects who read into the REQ scored more positively. A similar result appears from considering the three other subjects in other groups who reported that they read into the REQ ($\bar{X}$ = 8.7). Therefore, it appears that the

TABLE V

RESPONSES OF SUBJECTS IN EACH GROUP ON THE RESEARCH EVALUATION QUESTIONS

Question	Response				
	UF	UM	FF	FM	r to Total
1. In your opinion, how much of a contribution will this study make to the field of psychology?	-5	16	0	2	.60
2. How much did you like participating in the study just recently conducted?	-18	-6	-12	-18	.73
3. How worthwhile was it to participate in the study just recently conducted?	-10	0	-14	-21	.64
4. If you were asked by the Experimenter to volunteer for another study he was conducting, would you volunteer?	-10	32	-20	-7	.75
5. In your opinion how competent was the Experimenter who conducted the experiment in which you participated?	14	31	13	20	.68
6. What is your reaction now to the Experimenter who conducted this experiment? How much do you like or dislike him?	1	11	1	-1	.76
7. Is there anything you disliked about the experiment?	-32	-2	-7	-28	.74

REQ was scored more negatively by subjects who did not read into it.

The mean heart rate recovery from resting heart rate for the eight subjects in the unfit male group who read into the REQ was 12.6 and the mean for the two subjects who did not read into the REQ was 8.5. This suggests that even though the subjects read into the questionnaire they did not show an increase in heart rate recovery. In summary, the REQ results show that subjects who didn't read into the REQ showed a similar negative rating towards the experiment and experimenter.

TABLE VI

AFFIRMATIVE RESPONSES BY GROUPS FOR POST EXPERIMENT INTERVIEW

Questions	Responses			
	UF	UM	FF	FM
1. Were you ever frustrated at me during this experiment?	9	9	10	10
2. Were you ever frustrated at yourself during this experiment?	3	5	5	3
3. Did you read into the questionnaire?	1	8	1	1

The above analyses were based on data from only 40 of the 70 subjects who completed both parts of the experiment. Table VII contains mean scores for the remaining 30 subjects on each of the variables of interest, as well as comparisons of each group to the scores of the total group for each sex. The fit and unfit groups show highly significant differences from the total group on predicted MVO_2 scores (the score on which the groups were formed). The only other significant differences are the higher basal heart rates of the unfit subjects and two differences in recovery heart rate change. In no case is the remaining group different from the total group.

Correlational Analysis

Pearson product moment correlation coefficients between predicted MVO_2, REQ, basal heart rate, I.Q. heart rate change, stress heart rate change and recovery heart rate change over all 70 subjects were calculated. The correlation matrix is presented in Table VIII.

The correlational results reveal exactly the same findings as the previous analyses on the four groups. Predicted MVO_2 scores were found to correlate negatively with both the basal heart rate ($r = -.428$, $df = 68$ $p < .01$) and the recovery heart rate change ($r = -.322$, $df = 68$ $p < .01$). The significant correlation between recovery heart rate change and predicted MVO_2 is parallel to the previous significant difference between fit and unfit subjects in their heart rate change scores after five minutes of recovery. Both results indicate that the heart rates of fit subjects returned significantly closer to baseline

TABLE VII

Mean Scores for the Remaining 30 Subjects and Comparisons of Each Group to the Scores of the Total Group (Male or Female)

	N	Basal HR	IQ HR Ch.	Stress HR Ch.	Recovery HR Ch.	REQ Score	Predicted MVO_2
Males							
Fit	10	68.4	8.0	33.9	7.9	-5.1	46.4***
Unfit	10	81.4*	8.9	31.3	11.8*	8.0	26.6***
Remaining	21	74.8	4.6	30.1	7.0	.9	36.3
Total	41	74.4	6.5	31.5	8.4	1.2	36.1
Females							
Fit	10	73.2	6.3	33.6	2.8**	-3.9	50.0***
Unfit	10	91.4*	6.3	36.7	17.2	-6.4	28.9***
Remaining	9	80.5	8.4	36.2	13.8	-0.4	38.0
Total	29	81.7	7.0	35.6	10.8	-3.7	39.0

* p .05
** p .01
*** p .001

TABLE VIII

CORRELATIONAL MATRIX

	MVO_2 (1)	REQ (2)	Basal H.R. (3)	IQ H.R. Chg. (4)	Stress H.R. Chg. (5)	Recovery H.R. Chg. (6)
(1)	-	-	-	-	-	-
(2)	-.108	-	-	-	-	-
(3)	-.428*	-.099	-	-	-	-
(4)	.013	-.002	.032	-	-	-
(5)	.132	-.006	-.219	.437*	-	-
(6)	-.322*	-.062	.027	.342*	.511*	-

* $p < .01$.

levels than the heart rates of unfit subjects. No relationship was observed between the REQ and any of the other variables. Predicted MVO_2 scores did not correlate with stress heart rate change. This is the same result as the insignificant difference between the fit and unfit groups on this measure, and indicates that fitness level is not related to the degree of emotional arousal initially produced by the frustration. Basal heart rate did not correlate with recovery heart rate change (r = .027, df = 68, N.S.) which suggests that it is not the basal heart rate but how fit one is (predicted MVO_2 score) that accounts for the recovery from stress or frustration.

It should be noted that significant positive correlations were found between I.Q. heart rate change, stress heart rate change, and recovery heart rate change (r's = .437, .342, .511). This probably indicates that subjects showed a similar pattern of response to each of these three situations. For example, a subject showing a large increase in heart rate to I.Q. testing tended to also show a high heart rate increase to stress and his heart rate tended to remain elevated during the recovery period.

DISCUSSION

The results of this experiment did not reveal any differences between fit and unfit individuals in the degree of emotional arousal produced by an emotionally stressful situation.

Both dependent measures supported this conclusion. Heart rates across all four groups increased substantially during frustration but no significant differences were found between groups. Responses on the REQ were also similar but indicating the frustration manipulation successful by generally negative responses overall. In addition, in the post experiment interview all subjects reported being frustrated at some point in the experiment. The two individuals who reported not being frustrated at the experimenter indicated they were frustrated with themselves.

The major finding of the present study was that even though fit and unfit individuals were equally affected by frustration and insult, the fit people recovered more quickly from this psychologically stressful situation.

An additional finding in the present study was that fit females relative to unfit females recovered from the effects of frustration and insult to a greater degree than did fit males relative to unfit males. The implications of this sex difference are worth mentioning. As previously noted the female sample used in the present study had higher fitness levels than the males. This sample difference cannot directly explain the significant interaction effect. On the basis of this one would only expect a significant main effect of sex which was not found. Whether the obtained difference in recovery was due to sampling error or to some sort of interaction between a male experimenter and a female subject or

reliable difference between how fitness affects males and females is a question that should be answered by future empirical research.

Consideration of the finding that the females were more fit is also necessary. It may be that in the population tested females were more fit than males. An alternative possibility is that males were more motivated to volunteer whether they were fit or unfit. Following this line of thought, females may have been more bothered by being unfit than males and therefore the unfit female might not volunteer as readily as the unfit male or just generally not be as ready to go into experiments especially ones involving physical fitness testing. With random sampling future experiments could provide a definitive answer to this question.

Men are known to have lower heart rates than women (e.g. Kimber, Gray, Stackpole and Leavell, 1961). In the present study the males had lower heart rates, but this difference only approached significance.

An additional finding of importance in this study was that basal heart rate did not correlate with recovery from frustration and insult. The fact that this correlation was non-significant indicates that predicted MVO_2 was a better predictor of recovery from psychological stress than basal heart rate. This lack of a correlation is somewhat surprising, since basal heart rate correlates -.428 with predicted MVO_2 score.

No differences between groups were indicated by the REQ which was designed to measure the effects of frustration and insult directed toward the experiment and at the experimenter. The correlational data shows the REQ to be internally consistent. Other studies have shown its validity (Feshbach 1955, 1961 and Fishman 1965). In the present study validation could not be confirmed because a control group or nonfrustration condition was not used. According to the validational studies of Feshbach and Fishman scores near zero such as obtained here are certainly lower than would be expected from a non-frustrated group.

On the post-experimental interview, eleven subjects reported they read into the REQ, eight of which were in the unfit male group. It seems that the unfit male group was more suspecting and evaluative of the experiment. It is not clear whether this might be a difference reliably correlated with fitness level, or whether it was simply due to chance.

In relation to individual items in the REQ, questions which were concerned with the experimenter were responded to more positively than those directed toward the experiment. For example, the question, "How much did you like participating in this experiment?" was answered consistently negative. Whereas, to the question, "How competent was the experimenter?" responses were consistently positive. It is possible to infer that subjects were intimidated by the presence of the experimenter. The subjects may have replied

more positively to questions which concerned the experimenter for fear he might read their replies. In the questions concerned with the experiment the results imply that the subjects may have felt free to answer negatively.

An issue not dealt with in the present study is that of causality. Did the fit people recover faster from the frustrating situation because of their fitness levels per se or because of some other characteristic they possess? Causality can not be inferred due to the fact that the design used was correlational. People were fit or unfit presumably not only because of hereditary reasons but also because of personality differences. Fitness level was not manipulated in this experiment. There are certainly other variables which are confounded with fitness level and which may have had a causal role in the present finding of faster recovery from stress. For example, motivation or interest in sports is one of these other characteristics which may in turn cause the individual to become physically fit. Perhaps participating in sports demands recovering quickly from emotional stress. In this study fitness was not a treatment the experimenter manipulated. Some researchers have manipulated fitness levels through training programs (Cureton 1963 and Weingarten 1973) to supplement the correlational data on the importance and benefits of physical fitness. Future research should determine whether the difference in heart rate recovery between fit and unfit subjects found here will also appear when fitness level

is manipulated through training programs.

One issue that should be considered is the validity of the interpretations formulated from the present data. More specifically, since heart rate was used in establishing the independent variable i.e. predicted MVO_2 or fitness level and the main finding, faster heart rate recovery, also involved heart rate, is it possible that this result is an artifact of some sort? It is perhaps an unfortunate coincidence that the method for predicting an individual's fitness and the measure used to assess emotional arousal both involve heart rate. However, close examination of the data suggests that such artifacts are unlikely. First, predicted MVO_2 is not derived from basal heart rate level, but from the level the subject displayed after working for at least six minutes on a bicycle ergometer. This increased heart rate level together with the subject's body weight and workload are combined to determine a predicted MVO_2 scale. The predicted MVO_2 score's correlation with basal heart rate ($r = -.428$, Table VIII) is likely due to the known fact that basal heart rate tends to decrease as physical fitness increases rather than being an artifact of the way the predicted MVO_2 score was determined. Further, if basal heart rate was assumed to be the common variable linking the independent and dependent variables, i.e. predicted MVO_2 score and heart rate recovery change score, of this study, then

one would certainly expect a high correlation between basal heart rate level and the heart rate recovery change score. This correlation might be expected to be even higher than the correlation of predicted MVO_2 score and heart rate recovery change score. In contrast to this expectation the correlation between basal heart rate and heart rate recovery change score ($r = .027$, Table VIII) is small and insignificant. This result is quite different from what would be expected if the predicted MVO_2 score was a simple extrapolation of basal heart rate scores. Clearly this result shows that predicted MVO_2 scores are more closely related to the recovery of heart rate following psychological stress than is the basal heart rate level.

An alternative argument for an artifact might be based on the view that it is not basal heart rate but the elevated heart rate level which is the factor linking the two variables. That is, the predicted MVO_2 score is derived from an elevated heart rate from working on the bicycle ergometer, and the recovery heart rate change score is derived from a heart rate elevated by emotional stress. More specifically, the obtained result might be mediated by a common pattern of heart rate response to stress either physical or emotional. This view although seemingly plausible on the surface, does not result in predictions consistent with the obtained data. First, if a similar pattern of heart rate response to stress was the mediating factor, the subjects with lower elevated

heart rates i.e. fit subjects, would also be expected to show lower heart rate increases in their response to the frustration manipulation. The obtained correlation between predicted MVO_2 and heart rate change score during frustration was small and insignificant ($r = 0.132$, Table VIII) arguing against the present studies results being an artifact of a general heart rate response pattern to stress. To eliminate this sort of possible confounding, future research using predicted MVO_2 scores should utilize other measures in addition to heart rate (e.g. muscle tension).

It appears that the present results indicate that individuals who show a lower heart rate when working at a fixed workload than individuals of comparable body weight also tend to show faster heart rate recovery following emotional stress. It seems reasonable to infer that the factor which mediates this relationship is fitness level. This is an inference not a conclusion, but a seemingly reasonable inference and one that has important implications for understanding the benefits of physical fitness. For example, the occurrence of quicker recovery from stress for the fit group suggests a psychological benefit of being physically fit. This result may indicate that physically fit persons "cool off" faster than unfit persons following emotional stress.

REFERENCES

Allport, Gordon W., & Allport, Floyd H. Manual for the A-S reaction study. Cambridge: Houghton Mifflin Co., 1928.

Astrand, I. Aerobic work capacity in men and with special reference to age. Acta Physiology Scandanavia, 49 (Supplement 169), 1960.

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

Astrand, P. O., & Saltin, B. Maximal oxygen uptake and heart rate in various types of muscular activity, Journal of Applied Physiology, 1961, 16, 977 - 981.

Astrand, P. O., & Rodahl, K. Textbook of work physiology, McGraw-Hill, New York, 1970.

Astrand, P. O., Health and fitness, Pamphlet; A publication by Skandia Insurance Company L.T.D. Stockholm and the Swedish Information Service, 1973.

Balke, B. A simple field test for the assessment of physical fitness, Cari Report, Oklahoma City: Civil Aeromedical Research Institute, Federal Aviation Agency, 1963.

Berggren, G., & Christensen, E. H. Heart rate and body temperature as indices of metabolic rate during work, Arbeitsphysiology, 1950, 14, 255 - 258.

Berkowitz, L. Roots of aggression, New York: Atherton Press, 1969.

Breen, James L. Anxiety factors related to physical fitness variables, Urbana: Ph.D. thesis, Univ. of Illinois, 1959.

Brozek, Josef. Personality of young and middle aged normal men. Journal of Gerontology, 1952, 7, 410 - 414.

Burnstein, E., & Worchel, P. Arbitrariness of frustration and its consequences for aggression in a social situation. Journal of Personality, 1962, 30, 528 - 541.

Buskirk, E. & Taylor, H. L. Maximal oxygen intake and its relation to body composition with special reference to chronic physical activity and obesity. Journal of Applied Physiology, 1957, 11, 72 - 78.

Buss, A. H. The psychology of aggression. New York: Wiley, 1961.

Buss, A. H. Instrumentality of aggression, feedback and frustration as determinants of physical aggression. Journal of Personality and Social Psychology, 1966, 3, 153 - 162.

Carkhuff, R. The development of human resources, New York: Holt, Rinehart and Winston, 1971.

Carkhuff, R., Banks, G., Berensen, B., Griffin, A. & Hall, R. The selection and training of correctional counsellors on physical, emotional and intellectual indexes. Journal of Counselling Psychology, 1971, 18, 24.

Cattell, R. B., & Eber, H. W. Manual form A & B sixteen personality factor questionnaire. Institute for Personality and Ability Testing. Champaign, Illinois, 1962.

Cooper, K. H. Aerobics, M. Evans and Company, Inc. New York, 1968.

Cooper, K. H. The new aerobics, Bantam Books, New York, 1972.

Cureton, T. K. Improvement of psychological states by means of exercise fitness programs. Journal of the Association of Physical and Mental Rehabilitation, 1963, 17, 14 - 25.

Cureton, T. K. The physiological effects of exercise programs on adults. Charles C. Thomas: Publisher, Springfield, Illinois, 1969.

Doob, A. N. & Kirshenbaum, H. M. The effects on arousal of frustration and aggressive films. Journal of Experimental Social Psychology, 1973, 9, 57 - 64.

Duffy, E. Activation and behavior. New York: Wiley, 1962.

Edwards, A. L. Edwards personal personal preference schedule (manual). Psychological Corporation, New York, 1954.

Elliot, R. Tonic heart rate: experiments on the effects of collative variables lead to a hypothesis about its motivational significance. Journal of Personality and Social Psychology, 1969, 12, 211 - 228.

Evans, J. F. Resting heart rate and the effects of an incentive. Psychonomic Science, 1972, 26, 99 - 100.

Evans, J. F. Motivational effects of being promised an opportunity to engage in social comparison, Psychological Reports, 1974, 34, 175 - 181.

Feshbach, S. The drive-reducing function of fantasy behavior, Journal of Abnormal and Social Psychology, 1955, 50, 3 - 11.

Feshbach, S. The stimulating versus cathartic effects of a vicarious aggressive activity. Journal of Abnormal and Social Psychology, 1961, 63, 381 - 385.

Fishman, C. G. Need for approval and the expression of aggression under varying conditions of frustration. Journal of Personality and Social Psychology, 1965, 2 (6), 809 - 816.

Geen, R. G., & Berkowitz, L. Some conditions facilitating the occurrence of aggression after the observation of violence. Journal of Personality, 1967, 35, 666 - 676.

Geen, R. G. Effects of frustration, attack and prior training in aggressiveness upon aggressive behavior. Journal of Personality and Social Psychology, 1968, 9, 316 - 321.

Gentry, W. D. Effects of frustration, attack and prior aggression training on overt aggression and vascular processes. Journal of Personality and Social Psychology, 1970, 16, 718 - 725.

Glassford, R. G., Baycroft, C. H. Y., Sedgwick, A. E. & Macnab, R. E. J. Comparison of maximal oxygen uptake values determined by predicted and actual methods. Journal of Applied Physiology, 1965, 20, 509 - 513.

Gutin, B. Effect of increase in physical fitness on mental ability following physical and mental stress. The Research Quarterly, 1966, 37, 211 - 220.

Gutin, B.& DeGennaro, J. Effect of one-minute and five-minute step-ups on performance of simple addition. The Research Quarterly, 1968a, 39, 81 - 85.

Gutin, B.& DeGennaro, J. Effect of treadmill run to exhaustion on performance of long addition. Research Quarterly 1968b, 39, 958 - 964.

Hammerton, M.& Tickner, A. M. Physical fitness and skilled work after exercise. Ergonomics, 1968, 11, 41 - 45.

Harris, D. V. Comparison of physical performance and psychological traits of college women with high and low fitness indices. Perceptual and Motor Skills, 1963, 17, 293 - 294.

Hart, M., & Shay, C. Relationship between physical fitness and academic success. Research Quarterly, 1964, 35, 443 - 445.

Hokanson, J. E. The physiological bases of motivation. John Wiley and Sons, Inc. New York, 1969.

Hokanson, J. E. & Burgess, M. The effects of three types of aggression on vascular processes. Journal of Abnormal and Social Psychology, 1962, 64, 446 - 449.

Hokanson, J. E. & Burgess, M. Effects of physiological arousal level, frustration, and task complexity on performance. Journal of Abnormal and Social Psychology, 1964, 68, 698 - 702.

Kimber, D. C., Gray, C. E., Stackpole, C. E., & Leavell, L. C. Anatomy and physiology. New York: MacMillan, 1961.

Kregerman, J. J.& Worchel, P. Arbitrariness of frustration and aggression. Journal of Abnormal and Social Psychology, 1961, 63, 183 - 187.

Larson, L. A. Some findings resulting from the army air force physical training program, Research Quarterly, 1946, 17, 144 - 164.

Metz, K. F. The relationship between maximum aerobic capacity and physical fitness in 12 through 15 year old boys. Unpublished doctoral dissertation, University of Minnesota, 1967.

Morgan, W. P. Psychological considerations. Journal of Health, Physical Education & Recreation, Nov./Dec., 1968.

Morgan, W., Roberts, J., Brand, F., & Feinermain, A. Psychological effects of chronic physical activity. Medicine and Science in Sports, 1970, 2, 213 - 217.

Rarick, G., & Mckee, R. A study of twenty third-grade children exhibiting extreme levels of achievement on tests of motor proficiency. Research Quarterly, 1949, 20, 142 - 151.

Rowell, L. B., Taylor, H. L., & Wang, Y. Limitations to prediction of maximal oxygen uptake. Journal of Applied Physiology, 1964, 19, 919 - 927.

Rule, B. G., & Hewitt, L. S. Effects of thwarting on cardiac response and physical aggression. Journal of Personality and Social Psychology, 1971, 19, 181 - 187.

Schachter, S., & Singer, J. E. Cognitive, social and physiological determinants of emotional state. Psychological Review, 1962, 69, 379 - 399.

Schachter, S. Emotion obesity and crime. New York: Academic Press, 1971.

Scott, M. G. Physical activities contributions to psychological development. Research Quarterly, 1960, 31, 307.

Selye, H. The stress of life. McGraw-Hill Book Company, New York, 1956.

Sessoms, H. D. Measuring outcomes in terms of socialization and the mental health of the individual. In Recreation Research. Washington, D. C.: AAHPER, 1965.

Smart, R. & Smart, M. Krans-Weber scores and personality adjustment of nursery school children. Research Quarterly, 1963, 34, 199 - 205.

Spiegel, S. B. & Zelin, M. Fantasy aggression and the catharsis phenomenon. The Journal of Social Psychology, 1973, 91, 97 - 107.

Stroop, J. R. Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 1935, 18, 643 - 661.

Taylor, H. L., Buskirk, E., & Henschel, A. Maximum oxygen intake as an objective measure of the cardio-

respiratory performance. Journal of Applied Physiology, 1955, 8, 73 - 80.

Teraslinna, P., Ismail, A. H. & D. F. MacLeod. Nomogram by Astrand and Ryhming as a predictor of maximum oxygen intake. Journal of Applied Physiology, 1966, 21, 513.

Tillman, K. Relationship between physical fitness and selected personality traits. Research Quarterly, 1965, 35, 483 - 487.

Van Huss, W. Physical activity in Modern Living. Englewood Cliffs, N. J.: Prentice Hall, 1960.

Weingarten, G., & Alexander, J. P. Effects of physical exertion on mental performance of college males of different physical fitness level. Perceptual and Motor Skill, 1970a, 31, 371 - 378.

Weingarten, G. Effect of cardiorespiratory conditioning increase upon mental performance under physiological stress and on personality variables. Unpublished Doctorate Dissertation, University of Minnesota, 1970b.

Weingarten, G. Mental performance during physical exertion. The benefit of being physically fit. International Journal of Sport Psychology, 1973, 4, (1), 16 - 26.

Wells, H. P. Relationship between physical fitness and psychological variables, Urbana: Ph.D. thesis, Univ. of Illinois, 1958, 134.

Wechsler, D. Wechsler adult intelligence scale (manual) The Psychological Corporation, New York, 1955.

Weybrew, B. B. Patterns of psychophysiological response to military stress in Appley M. H., and Trumbull R. Psychological stress: Issues in research, 1967, 324 - 362.

Yerkes, R. M., Dodson, J. D. The relation of strength of stimulus to rapidity of habit forming. Journal of Comparative and Neurological Psychology, 18: 459 - 482, 1908.

APPENDICES

Appendix — Page

APPENDIX A

Comprehension Subtest:

1. What does this saying mean? "Strike while the iron is hot."

2. Why are child labor laws needed?

3. If you were lost in the forest in the daytime, how would you go about finding your way out?

4. Why are people who are born deaf usually unable to talk?

5. Why does land in the city cost more than land in the country?

6. Why does the state require people to get a license in order to be married?

7. What does this saying mean? "Shallow brooks are noisy."

8. What does this saying mean? "One swallow doesn't make a summer."

Note: answers to these comprehension items can be found in WAIS Manual pp. 54-59.

Arithmetic Subtest:

	Problems and Answers	Answer
1.	How many oranges can you buy for 36 cents if one orange costs six cents?	6
2.	How many hours will it take a man to walk 24 miles at the rate of three miles an hour?	8
3.	If a man buys seven two-cent stamps and gives the clerk a half dollar, how much change should he get back?	36 cents
4.	A man with $18 spends $7.50. How much does he have left?	$10.50
5.	The price of canned peas is two cans for 31 cents. What is the price of one dozen cans?	$1.86
6.	A man bought some secondhand furniture for two thirds of what it costs new. He paid $400 for it. How much did it cost new?	$600
7.	A worker's salary is $60 per week. If 15% of his pay is withheld for taxes, how much does he receive each week?	$51
8.	Eight men can finish a job in six days. How many men will be needed to finish it in a half day?	96

General Information Subtest:

	Test Questions	Acceptable Responses
1.	What does rubber come from?	Trees ... Sap of trees ... Rubber plant ... Petroleum ... Alcohol.
2.	What are the four seasons of the year?	Winter, Spring, Summer and Fall.
3.	What color are rubies?	Red.
4.	How many weeks are there in a year?	52.
5.	What does C.O.D. mean?	Cash on Delivery.
6.	Where is Brazil?	South America. (If some other correct answer such as, "East of Bolivia," or, South of Venezuela," is given, ask, "In what continent is Brazil?")
7.	How tall is the average Canadian woman?	Any answer from 5'3" to 5'6", inclusive.
8.	What is the capital of Italy?	Rome.
9.	Why are dark clothes warmer than light-colored clothes?	Dark clothes absorb heat from sun ... Light clothes reflect (repel) heat from sun.
10.	When is Dominion Day?	July 1st.
11.	Who wrote Hamlet?	Shakespeare.
12.	What is the Vatican?	Home of the Pope ... Seat of papal government.
13.	How far is it from Paris to New York?	Any answer from 3000 to 4000 miles.

14. Where is Egypt?	Africa. (If some other correct answer such as, "Southeast shore of Mediterranean," is given, ask, "In what continent is Egypt?")
15. How does yeast cause dough to rise?	It ferments producing carbon dioxide bubbles causing dough to swell ... Gases are formed ... It ferments ... It expands ... It forms air bubbles.
16. What is the population of Canada?	20,000,000 - 22,000,000.
17. What is a harrow?	Farm implement.
18. What is the main theme of the Book of Genesis?	Creation ... Beginning of the world ... Beginning of man ... Early Hebrew history.
19. At what temperature does water boil?	212^{o} F ... 100^{o}C. (If scale is not specified, ask, "What scale?")
20. Who wrote the Iliad?	Homer.
21. Name three kinds of blood vessels in the human body.	Arteries, veins, and capillaries. (Names of specific vessels not acceptable, but give credit for venules and arterioles).
22. What is the Koran?	Mohammedan scriptures ... Mohammedan sacred writings ... Mohammedan Bible. (Moslem in place of Mohammedan is acceptable.

23.	Who wrote Faust?	Goethe ... Gounod.
24.	What is ethnology?	The study of races.
25.	What is the Apocrypha?	Books of disputed authority in the Old Testament ... The reputedly unauthenticated or unacceptable parts of the Bible.

APPENDIX B

Letter of Instruction and Accompanying
Research Evaluation Questionnaire. (REQ)

TELEPHONE 345 2121
AREA CODE 807

Lakehead University
THUNDER BAY, ONTARIO, CANADA, POSTAL CODE P7B 5E1

DEPARTMENT OF PSYCHOLOGY

March 15, 1974

Thank you for taking part in this experiment. It is my practice always to obtain the views of each subject following any experiment which I am supervising. Your views may enable me to detect possible weaknesses in the experiment and will provide a basis for evaluating the experimenter, especially in the case where I must submit a grade for his research. Please answer the following questions and seal the questionnaire in the envelope addressed to me.

Your cooperation is appreciated.

Yours truly,

John Jamieson

J. Jamieson, Ph.D.
Assistant Professor

JJ/ml

Research Evaluation Questionnaire

1. In your opinion, how much of a contribution will this study make to the field of psychology? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(none) (a lot)

2. What thoughts do you have about the experiment?

3. How much did you like participating in the study just recently conducted? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(not at all) (very much)

4. How worthwhile was it to participate in the study just recently conducted? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(complete waste of time) (considerably worthwhile)

5. If you were asked by the Experimenter to volunteer for another study he was conducting, would you volunteer? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(definitely not) (definitely yes)

6. What was this experiment about?

7. Did you hear anything about this experiment before?

8. Do you know the Experimenter personally?

9. In your opinion how competent was the Experimenter who conducted the experiment in which you participated? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(extremely incompetent) (extremely competent)

10. What is your reaction now to the Experimenter who conducted this experiment? How much do you like or dislike him? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(dislike very much) (like him very much)

11. Have you participated in similar experiments before?

12. Is there anything you disliked about the experiment? *(circle one)*

-5 -4 -3 -2 -1 1 2 3 4 +5

(yes) (no)

13. Do you have any ideas or suggestions of how this experiment could be improved?

APPENDIX C

Letter of Explanation for the Procedure of the Second Part of the Experiment.

TELEPHONE 345 2121
AREA CODE 807

71

Lakehead University
THUNDER BAY, ONTARIO, CANADA, POSTAL CODE P7B 5E1

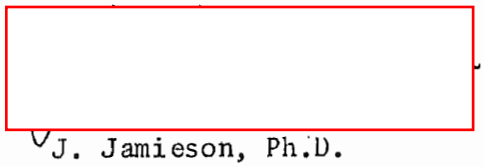
DEPARTMENT OF PSYCHOLOGY

March 15, 1974

Many Psychological experiments involve deception, in which it is essential that the subject is not made aware of the true purpose of the experiment. This is such an experiment. We were really interested in how physical fitness affects the response of individuals to a frustrating or irritating situation. Mr. Cox intentionally tried to upset you by being rude and insulting. We have measured your response to this situation in two ways, by your heart rate change, and by your comments about the experimenter on the Research Evaluation Questionnaire. Clearly if deception was not used and you were aware of what we were doing, you would not have been upset. Therefore, it is essential that you do not discuss this experiment with anyone until after the experiment is completed, or the response of future subjects may be spoiled.

Again I would like to thank you for participating. Within a week of the experiment being completed we will mail you a brief description of the results of the experiment, indicating whether we found such a relationship, as well as your personal fitness score as obtained by Dr. Lavoie's lab.

Sincerely,



J. Jamieson, Ph.D.
Assistant Professor

JJ/ml