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# THE USE OF PERCEIVED EXERTION TO DIFFERENTIATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL EDUCABLE MENTALLY HANDICAPPED WORK-STUDY STUDENTS

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# CHAPTER I

## INTRODUCTION

During the past several years, considerable amounts of time, effort, and money have been expended in an attempt to increase the efficiency of vocational training and job placement for educable mentally handicapped students from public schools (Tuttle, 1978). Considering the time, effort and money, little research has been conducted that can conclusively predict the employability and vocational success of the educable mentally handicapped student. Most available research has been conducted with normal students. Consequently, many factors that are relative to predictive vocational tests such as reading level are inappropriate for use with the educable mentally handicapped student.

Students enrolled in the vocational work-study program attend academic classes one-half day and are placed in job situations the other half day. The basic objective of the work-study program is to develop a skill that will allow the student to maintain a meaningful work situation upon completion of high school (Walraven, 1976). The placement problem of the educable mentally handicapped student has been due in part to the improper analysis of students, jobs and employers. Warren (1955) concluded that the problem of

job frustration among EMH students was the result of academic weaknesses compounded by social and emotional immaturity. He also cited other individual weaknesses such as physical activity and personality difficulties.

In order to understand the EMH students at work, researchers should not only consider their physical abilities and performances, but also psychological characteristics, inabilities to cope with job related stresses, and the individual complexities associated with particular jobs. It is entirely possible that the EMH students' perceptions of work tolerance do not agree with the work capacity being measured (Bartley, 1970). Such measurements are required for desirable clinical diagnosis, therapy, exercise prescription, evaluation and prognosis. Meanwhile, EMH students' achievement and perceptions should be studied in order to increase the possibility of such persons becoming more efficient and self-satisfied employees.

In order to predict the employability of any particular individual or group of individuals it is necessary to isolate those factors which are found to be related to successful employability. In particular, physicians, psychologists, and physical education teachers are interested in knowing how the individual perceives his intensity of physical exertion. Research in the area of perception of physical exertion has been conducted primarily by Borg (1971). Working primarily with clinical and applied

psychology, Borg has found that it is an important consideration to know what physical exertion the subject feels is being expended as opposed to the amount of physical energy actually being expended. In most studies, Borg has found that the continuation of work, as well as the intensity at which one elects to work, is dependent in part upon the processing of perceptual information.

## Statement of the Problem

The problem investigated in this study had its origins in the discrepancies noted between the employment patterns of two groups of educable mentally handicapped students. One groups of EMH students was observed being placed in work situations where workers performed successfully for relatively long periods of time. Others placed in similar work situations were not able to perform successfully, and sometimes left the job the same day or failed to report for work the second day. Examination of the work situations assigned the successfully-employed and unsuccessfully-employed students observationally revealed no obvious differences as far as type, difficulty, or prestige level of jobs. Able (1940) determined that the most important single factor concerning work success was the proper placement of students in work situations which met their unique psychological needs and were comparable to the physical capabilities and limitations of individual participants. With

Able's and Bartley's studies, combined with observations and experiences, the researcher designed the study to determine perceived exertion capabilities of successfully-employed EMH students and the perceived exertion capabilities of unsuccessfully-employed EMH students.

Hypotheses Tested in the Study

The following null hypotheses were tested for significance at the .05 level.

$Ho_1$ There were no statistically significant differences between the mean rate-of-perceived-exertion (RPE) ratings made by the successfully-employed work-study students and the mean rate-of-perceived-exertion (RPE) ratings made by the unsuccessfully-employed work-study students across all work-load levels.

$Ho_2$ There are no statistically significant differences among themean rate-of-perceived-exertion (REP) ratings made by participants at the light (300 kpm/min), moderate (450 kpm/min) and heavy (600 kpm/min) work loads when their heart rates are taken into consideration as a covariate.

$Ho_3$ There is no statistically significant interaction between the independent variables of Group (successfully-employed and unsuccessfully-employed) and Work Load Levels (light, 300 kpm/min; moderate, 450 kpm/min and heavy, 600 kpm/min) as reflected in the participants' RPE ratings.

$Ho_4$ There is no statistically significant correlation between the Rate-of-perceived-exertion and heart rates of successfully-employed students and the RPE and HR of unsuccessfully-employed

work-study students while performing a work load of 300 kpm/min.

$Ho_5$ There is no statistically significant correlation between the Rate-of-perceived-exertion and Heart-rate of successfully-employed work-study students and the RPE and HR of unsuccessfully-employed work-study students performing a work load of 450 kpm/min.

$Ho_6$ There is no statistically significant correlation between the Rate-of-perceived-exertion and Heart-rate of successfully-employed work-study students and the RPE and HR of unsuccessfully-employed work-study students while performing a work load of 600 kpm/min.

$Ho_7$ There is no statistically significant difference between the mean congruency indexes of the successfully-employed work-study group and the mean congruency indexes of the unsuccessfully-employed work-study group.

$Ho_8$ There are no statistically significant differences among the mean congruency indexes as computed for students working at the light, moderate, and heavy work loads.

$Ho_9$ There is no statistically significant interaction between the independent variables of Groups and Work-Load Levels as reflected in the participants congruency indexes at the light, moderate, and heavy work loads.

## Definitions

For use in this study, the following definitions were used:

Bicycle Ergometer: An apparatus as a geared bicycle

wheel, for measuring the metabolism rate or the amount of energy expended in doing work.

Comfort System: The mechanisms of awareness, the sensory mechanism involved in this system . . . the sense of pain, temperature, kinesthesis, and touch, and even some of the receptors involved in homeostatic processes.

Congruency Index: The ratio of the RPE to the participants' heart rate divided by 10, with the largest number being the denominator.

Discomfort: State of being positively uncomfortable when one's subjective rating of the intensity of work was being performed.

Educable Mentally Handicapped Work-Study Student: Those students enrolled in the secondary school Special Education classes designed by the Oklahoma State Department of Education to provide academic instruction and job experience. The I.Q. range of the students is 50-75+ as determined by their performance on the Wechsler Adult Intelligence Scale or the Wechsler Intelligence Scale for Children (Revised).

Ergonomics: The study of the relationship between man and his working environment, with special reference to anatomical, physiological and psychological factors.

Exercise Bout/Trial: The 6-minute work program assigned to each subject under a specified work rate.

Exercise Heart Rate: The participants' heart rate taken during the final 30 seconds of the exercise bout.

Fatigue: Identifies a condition of lessened activity of an organism or any of its parts, resulting from prolonged exertion. A diminished susceptibility to stimulation of the central nervous system affecting primarily the function between nerve and muscle fibers.

Homeostatic: Being comprised of various internal receptors responsible for body regulation. The tendency of an organism to maintain a uniform and beneficial physiological stability within and between its parts, an organic equilibrium.

Kilo-Pound Meters/Per Minute (kpm/min): The measure of work being expended by participants to achieve a desired heart rate.

Pain: The sensation or feeling resulting from or accompaning some injury, derangement, overstrain, or obstruction of physical powers and distressing or afflicting emotions.

Physical Work Test: ($PWC_{170}$) is a sub-maximal work test designed to measure the relationship between work output and heart rate. This procedure monitors the participants and stops exercise at HR 170.

Rate of Perceived Exertion (RPE): The participants' subjective rating of the intensity of work being exerted during the final 30 seconds of the 6-minute work trial. Ratings were made on the Borg Rating Scale presented in Appendix B.

Teacher Coordinator: Those teachers certified by the Oklahoma State Department of Education to teach the Educable Mentally Handicapped Work-Study Program. The teacher was in the traditional academic setting during the morning session and the afternoon session was spent in securing and supervising the students in a work situation.

Work Loads:

Light Work Load: A 300 kpm/min work load as determined by the bicycle ergometer.

Moderate Work Load: A 450 kpm/min work load as determined by the bicycle ergometer.

Heavy Work Load: A 600 kpm/min work load as determined by the bicycle ergometer.

Work Rate: The amount of work expended by the subject at a given setting on the Monark Bicycle Ergometer. Work rate is measured in kilo-pound meters/per minute.

## Limitations of the Study

The primary limitations of the present study were related to the participants, measuring instruments, and the exercise equipment. The sample of successful participants was limited to male, educable-mentally-handicapped (EMH), 10th, 11th, and 12th grade students enrolled in work-study programs in central Oklahoma for more than 9 weeks of the 1977-78 school year. These students were rated the top 25 most successful employees on the rating scale shown in

Appendix A.

The sample of unsuccessful participants was limited to male, educable-mentally-handicapped (EMH), 10th, 11th, and 12th grade students enrolled in work-study programs in central Oklahoma for more than 9 weeks of the 1977-78 school year. These students were rated the 25 least successful employees on the rating scale shown in Appendix A.

The participants' rate of perceived exertion (RPE) was limited to a self-reported rating made on the Borg Rating Scale shown in Appendix B.

The work loads used on the bicycle ergometer were limited to 300, 450, and 600 kpm/min on the Monark Bicycle Ergometer used in the study.

# CHAPTER II

## RELATED RESEARCH

### Maximal Work Capacity

Investigators in work performance assessment have tried for many years to establish an appropriate method of evaluating an individual during physical performance. Astrand (1956) considered the highest work load performed prior to physical exhaustion, maximal working capacity, a useful method of evaluation. He also warned of the difficulty of the use of such a definition of physical performance. In his research, he found that some individuals would stop work performance before a maximum was reached. He concluded that this may be due to a number of factors such as disinclination to work harder, discomfort, and the unwillingness of clinicians to push a subject to exhaustion because of the possibility of cardiac catastrophe.

### Submaximal Work Capacity

As a result of criticisms of maximal working capacity tasks, Sjostrand (1947) reported the use of a submaximal working capacity test. His test required that a subject perform three different work loads of varying degrees of intensity. The last work load designed to produce a heart rate of approximately 170 beats per minute. This research

showed that a heart rate of 170 beats per minute to be associated with near maximal cardiac output and oxygen consumption in young adults.

## Maximal Endurance

Goldberg, Weiss, and Adams (1966) in an attempt to make use of both the maximal and submaximal test modified and combined features of both in an attempt to understand the working individual further. This physical test was referred to as maximal endurance. The test required that an individual perform at increasing work loads in short periods on the bicycle ergometer until exhaustion. The total amount of work performed was divided by the total length of time to perform the test. The value used to express the results was termed mean work to exhaustion.

## Maximal Oxygen Consumption

The working capacity test was not totally accepted as the best method to determine physical performance by all investigators. The aerobic or the maximal oxygen consumption was considered by many to be the best measure of overall fitness (Astrand, 1956). The test gave a measure of the functions of the heart, lungs, and peripheral vascular system. The equipment necessary to perform the test made its use outside the research laboratory impractical. Good predictions of maximal oxygen consumption could be made with $\pm$ 12% accuracy from submaximal tests (Astrand and Ryhming,

1954).

## Factors Affecting the Work Capacity

The variables that affected working capacity were body size, sex, heart volume, environment and training (Astrand, 1956; Adams, Bengtsson, Berven, and Wegelius, 1961). Buskirk and Taylor (1957) indicated that lean body weight and active tissue were the most important as related to body size. Except for the very young children, the sex difference was a factor in the working capacity (Astrand, 1956). With maximal heart rates the same for both sexes, the explanation for difference is unknown (Goldberg, 1966).

Holmgren, Johnsson, Levades, and Linderholm (1957) in studying the variable of heart volume which correlated directly with working capacity found that training through physical activity would increase the heart volume. The well trained individual had a much greater working capacity than the untrained individual. This greater ability to perform work was associated with a larger heart volume and better oxygen utilization (Buskirk and Taylor, 1957). Astrand (1956) indicated that the effect of training appeared to be more evident in the individual who was already an athlete, but had no effect on the working capacity of children.

The educable mentally handicapped student, because of

his intellectual limitation, was often limited to environmental jobs (manual labor, dishwashing, freight handling, janitoral). This made the research in the area of physical work capacity very important. Presently little research had been done with the educable mentally handicapped student concerning physical work capacity and how it affected vocational placement and adjustment.

## Psychological Effects of Work

Another area of concern was the psychological effects of work and how the individual perceived the work situation. Statements of opinion about the psychology of physical work had been appearing in literature for many years, but little empirical research was available (Layman, 1960). The last two decades the psychology of physical work in an empirical nature were appearing in literature.

## Visual Perception

Piaget (1966) argued that the sensorimotor period of development was essential for the later development of the ability to interpret and think. Kephart (1955) in working with retarded children demonstrated the potentialities of movement programs for the improvement of perceptual and problem-solving skills. Cratty (1971) pointed out that visual perception development preceded the maturation of motor competencies.

The studies below showed the relationships between perceptual and motor skills were positive and negative with the results varying by age, type of perception measured and the use of perceptual cues in motor activities. Haring (1967) studied the effects of physical development program on metally retarded children. The group who had a gross motor activity program showed significant improvement in visualmotor perception as compared to the control group. Chasey and Wyrick (1970) investigated the effects of a program of total-body movement on the educable mentally handicapped children's ability to understand selected geometric forms. Using the Block Design of the Wechsler Intelligence Scale for Children (WISC), the total-body movement program did not have a significant effect on the mentally handicapped student's ability to understand the geometric forms.

## Perceived Exertion

Another area of research related to the psychology of work is perceived exertion. The first experiments began in the late 1950's and differed from the typical psychological studies of exercise concerning personality, motivation or psychomotor performance. The research attempted to deal with the question of how the intensity of perception increased with the increased intensity of physical work.

In medical diagnosis, subjective symptoms were used

to identify clinical difficulties and the intensity of the discomfort. Bartley (1970) has pointed out the need to acknowledge a homeostatic and a comfort perceptual system. This would allow the subjective symptoms associated with physical work to be studied in the same manner as the medical diagnosis. As with objective data obtained from a work capacity test, subjective data can be collected and viewed as second class stress indicators. Bartley further examined five classes of receptors that participated in the homeostatic system and identified the need to quantify the subjective data. Perception of exertion was one of the important subjective responses in the homeostatic-comfort systems.

## Estimates of PWC from RPE

Borg (1962) originated the first studies that dealt with physophysical problems of subjective force and perceived exertion. The studies investigated the possibilities of adapting ratio scaling to the perception of intensities of work. The results were described by the following expression, $R = a + c \cdot s^n$, where R was subjective force, a was perception distortion, c was measure-constant, and s the power in kpm/min.

To obtain simple direct measurements of the degree of perceived exertion several different scales were developed. The most often used scale for rating of perceived exertion (RPE) is the one which varied from 6 to 20 to approximate

one-tenth of HR (Borg, 1962) Table 1.

Borg (1962) was able to determine a very high correlation with the absolute HR ( $\frac{r}{xy}$ = .85) in a study that varied the work load from light to heavy work.

Borg's rating scale of perceived exertion was tested to see if it was a valid measure or indication of perceived exertion. Subjects were tested to see if they could tell the difference in work intensity when the work loads were presented in random order. There was little difference in the results of the random and the progressive bicycle ergometer tests, therefore, the progressive test was recommended because it was less time consuming.

A model for inter-individual comparison, a validation study, was used by (Borg, 1973) to compare four different rating methods: A = the RPE scale, B = a line scale (the subject marks the intensity of his perception on an 11-centimeter line to the left of which is written "no exertion at all", and to the right "Maximal exertion"); C = the old 21-point graded scale and D = a 9-point graded scale. The number 2 in scale D above is anchored with the expression, "not at all stressful" and number 8 with the expression, "very, very stressful".

Ratings of perceived exertion according to these methods were collected together with heart rates during two kinds of work tests. In the first test, the subjects started with a work load of 1400 kpm/min and worked as long as

TABLE 1

CORRELATION COEFFICIENTS BETWEEN HEART RATE (HR) AND RATINGS OF PERCEIVED EXERTION (R) USING VARIOUS RATING METHODS (A, B, C, and D), IN MAXIMAL WORK TEST AT A SINGLE LOAD (1400 kpm/min)

| Comparison | N | r |
|---|---|---|
| $R_A$ vs $HR_A$ | 69 | 62 |
| $R_B$ vs $HR_B$ | 69 | 61 |
| $R_A$ vs $R_B$ | 69 | 93 |
| $R_C$ vs $HR_C$ | 63 | 55 |
| $R_D$ vs $HR_D$ | 63 | 54 |
| $R_C$ vs $R_D$ | 63 | 92 |
| A - 6 to 20 scale | | C - 1 to 21 scale |
| B - Line scale | | D - 1 to 9 scale |

possible so that a measurement of maximal performance capacity, a $W_{max}$ according to Tornvall (1963), was obtained. The total working time varied from a few minutes to one-half hour. Most subjects stopped after six minutes. The subjects in the first experiment consisted of two similar groups of military conscripts, 18-19 years old. The first group (N=69) had to rate the exertion according to methods A and B, and the second group (N=63) according to methods C and D. Correlation coefficients were then calculated between the different rating methods.

In Borg's second experiment the subjects also went through a physical work test with step-wise increases of work load from 600 kpm/min with an increase of 300 kpm/min every 6th minute, (Sjostrand, 1947 and Wahlund, 1948). In this experiment, two groups of subjects were used, one with A and B (N=43), and the other with methods C and D (N=46). The results of the first experiment are shown in Table 1. The correlation coefficients between heart rate and perceived exertion ratings were similar for the different methods. The coefficients were not as high, perhaps, because of the restricted range of work intensity. The comparisom was between work of hard to very hard as compared to earlier studies when light to very hard was used. Table 2 gives corresponding coefficients from the second work test. The results were of the same size as Borg's first study. These two experiments indicated that good

TABLE 2

CORRELATION COEFFICIENTS BETWEEN HEART RATES (HR) AND RATING OF PERCEIVED EXERTION (R) USING VARIOUS RATING METHODS (A, B, C, and D), IN A MAXIMAL WORK LOAD WAS CHANGED EVERY 6 MINUTES (300 kpm)

| Comparison | N | r |
|---|---|---|
| $R_A$ vs HRA | 43 | .72 |
| $R_B$ vs $HR_B$ | 43 | .63 |
| $R_A$ vs RB | 43 | .83 |
| $R_C$ vs $HR_C$ | 46 | .60 |
| $R_D$ vs $HR_D$ | 46 | .52 |
| $R_C$ vs $R_D$ | 46 | .92 |
| A - 6 to 20 scale | | C - 1 to 21 scale |
| B - Line scale | | D - 1 to 9 scale |

correlations between heart rates and perceived exertion rating were obtained independently of which scale was used. There was a fundamental relationship between a physiological indicator of physical stress such as rating of perceived exertion.

In another attempt to test the validity of Borg's rating scale of perceived exertion 8 lean and 8 obese subjects participated in a study to determine whether they could perceive small differences in work intensity when the work loads were presented in a random order. It was shown that heart rate (HR) was linearly related to work intensity and could be used as a predictor of physical working capacity (Astrand, 1954, and Wahlund, 1948). The subjective rating of the intensity of exertion was perceived by the participants to be an indicator of the physiological work being done (Borg and Linderholm, 1967). Correlation coefficients from 0.77 to 0.90 were reported between HR and a subjective rating of perceived exertion (RPE), as assessed by the Borg (1962) scale. Results were uncertain as to whether these coefficients reflected the subjects' ability to perceive effort or were an artifact of the technique, since progressively increasing work loads were used. It was possible that the subjects in the study based their RPE of a particular work load on the information obtained from previous work loads. Since the work load and heart rate increased in a step-wise fashion, subjects could logically

have rated them in the same direction, which produces spuriously high correlations.

Therefore, the question remained whether man could perceive small differences in work intensity if the work loads were presented in a random order. If it could be assumed that such a randomized test were a test of validity then there was also the question regarding the validity of the RPE scale developed by Borg (1962). Stevens (1957) developed ratio methods by which comparisons could be made. The validation of rating methods was conducted by Skinner, Hutsler, Bergsteinova, and Buskirk, (1973).

These results were compared with those obtained using the line scale method. Reliability was determined by testing each subject twice with each protocol. The testing order of the two protocols and also the order of work loads used during the random test were assigned using a Latin square design. There were no significant differences in any of the physiological and perceptual variables between the 2 types of test protocols. Coefficients of reliability for both procedures ranged from .72 to .92. Whereas, the progressive test was recommended for use since it is less time consuming.

## Clinical Studies

Borg (1962) stated that, "In healthy subjects there is a fairly close relationship between heart rate during exercise and the subjective perception of exertion according to a rating method," and concluded that this relationship

changed with the age of the subject. In having used the rating of perceived exertion for several years in routine tests for the determination of the physical working capacity of patients there was a deviation from normal relationships between heart rate and rating of exertion. Borg and Linderholm (1970) reported that patients with arterial hypertension and coronary insufficiency rated the exertion high in relation to heart rate as compared with controls. In the study a standardized work test was performed by healthy subjects, patients with coronary heart disease, patients with arterial hypertension, and with vaso-regulatory asthenia syndrome. Heart frequency and rating assessed at various work loads and different measures of physical working capacity were based on heart rate and rating of perceived exertion was low in a vaso-regulatory asthenia syndrome group and high in patients with coronary insufficiency when compared with controls of equal age. Patients with a low maximal performance also had a low maximal physical working capacity estimated from heart frequency as well as from rating of perceived exertion. The difference found between the various patient groups, especially that between patients with coronary heart disease and patients with vaso-regulatory asthenia syndrome was of differential diagnostic value.

## Perceived Difficulty

A concept closely related to perceived exertion was

the tasks' perceived difficulty. The effort a man has to exert in solving a problem or achieving good physical performance reflected partly the difficulty of the task. Different kinds of performances varied in difficulty, and to understand the "subjective costs" to the individual who was performing a task required quantitative measurements with respect to the degree of difficulty involved. Also, when classifying and discriminating among different tasks, measurements of the tasks' difficulty were of importance.

Psychophysical studies of subjective difficulty were performed in a series of experiments concerning mental tasks. In an initial study by Borg and Forsling (1964), it was shown that the same kind of methods described in the preceding sections and used to measure perceived exertion of physical performance could be used to measure perceived difficulty of mental performances. Many different kinds of mental tasks had since been studied (Borg, 1962, 1971, 1973; Bratfish, 1971). In most experiments the perceived difficulty was found to grow linearly with the physical difficulty according to the usual psychometrical measurements (based on solution frequencies). In most cases, high correlations were obtained between subjective and objective measurements of difficulty.

## Physical Fitness and Mental Capacity

According to modern philosophy, when relating physical

activity, exertion, working capacity, and some psychofunction man cannot be divided into two separate parts, mental and physical. The psychological and the physiological functions are, on the contrary, integrated into a complex configuration. In modern medicine the existence of psychosomatic disease showed very clearly the interdependence of these two "entities", somatic disturbances have psychological effects and vice versa (Borg, 1971). According to anecdotal sports information and the general experiences of many people, a positive correlation existed between physical fitness and mental capacity (Morgan, 1973). Curiously enough, very few studies of an empirical nature had attempted to substantiate this claim. On the other hand, a few studies had been carried out concerning the relation between physical activation exertion, and certain psychological functions. In some of these studies physical work had been used to manipulate the degree of "arousal" and its effect on psychological functions. In the studies by Borg (1973) certain small changes were found in psychomotor and memory functions after moderate to hard physical work. The function most sensitive to physical stress was hand-arm steadiness, which began to deteriorate shortly after the onset of light physical stress and deteriorate further and further according to a somewhat positively accelerating function.

On the basis of findings from a few experimental

studies and some field experiments there seemed to be a small but positive correlation between physical fitness and mental functions such that people who were more physically fit were also more stable with respect to many psychological characteristics (Morgan, 1973). Most people also agreed that good physical fitness had a positive, therapeutic effect and gave a feeling of well-being, which might be one of the most important effects of physical exercise.

# CHAPTER III

## METHOD

In the present study, male students enrolled in a secondary work-study program offered by public school systems in central Oklahoma served as subjects in an experiment to determine if there were any differences between the perceived exertion rates of successfully and unsuccessfully employed students. The rate of perceived exertion of a group of successfully employed EMH students and a group of unsuccessfully employed EMH students were compared to test nine null hypotheses. Participants made exertion ratings while performing on a bicycle ergometer as their exercise heart rates were being continuously monitored.

### Sample

The population was comprised of 200 male Educable Mentally Handicapped (EMH) students in five secondary schools in central Oklahoma. The different schools were located in cross-sectional socio-economic areas.

Each subject was classified in the Educable Mentally Handicapped (EMH) range of intelligence which is from 50 to 75 IQ as determined by the Wechsler Intelligence Scale for Children (Revised) (WISC-R) or the Stanford-Binet L-M Test of Intelligence. These two testing instruments were selected as screening instruments by the Oklahoma State Department of

Education. Demographic data are presented in Appendix E.

The age range of the students was 15 to 18 years who were enrolled in the three upper grades in high school. Each student was physically capable of work and had been enrolled in the Work-Study program for at least nine weeks. Since the test required pedaling an ergometer, subjects were eliminated who could not perform this task but could maintain a work situation. Only male subjects were used in the sample to eliminate any sexual variance.

In selecting possible participants, teacher coordinators from the participating schools were sent forms to complete on each of the EMH students who was in the work-study program. A copy of the letters sent to these teacher coordinators is presented in Appendix A. The primary purpose of this letter was to identify possible participants for the study and to have the teacher coordinator rank order their most successful workers and their least successful workers.

Criteria for performing these rankings were developed by Warren (1961). Two areas of employment criteria were identified: (1) Social Adjustment Criteria and (2) Work Habit Criteria. The subareas of each were as follows:

I. Social Adjustment Criteria

1. Self-confidence
2. Cheerfulness
3. Cooperation with supervisor
4. Cooperation with fellow employees
5. Respects authority
6. Minds own business

7. Accepts criticism
8. Mixes socially with employees
9. Neat and clean

II. Work Habit Criteria

1. On time
2. Careful with materials
3. Completes work on time
4. Work is of good quality
5. Understands work
6. Shows initiative

The twenty-five male students considered the most successful (successfuls) and the twenty-five considered the least successful (unsuccessfuls) were selected from the qualified population. Informed consent was obtained from at least one parent of each subject after being fully appr ised of intended study.

## Instrumentation

Two instruments were used in collecting the data. A self-report inventory, Borg's Rate of Perceived Exertion Scale (RPE), is presented in Appendix B. Borg (1962) developed this instrument and established its reliability and validity through a series of perceived exertion studies. The modified scale was administered to the subjects the last thirty seconds of each exercise period. The modified scale consisted of 15 grades from 6 to 20 printed on a regular size sheet of paper. Each second number was accompanied by descriptive works as follows: 7 = very, very light; 9 = very light; 11 = fairly light; 13 = somewhat hard; 15 = hard; 17 = very, hard; 19 = very, very hard, which are shown in

Figure 1.

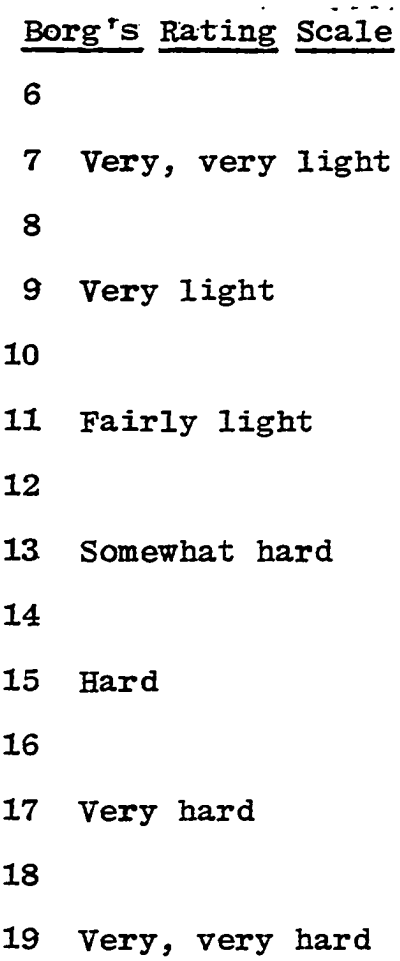


Fig. 1 The RPE scale for rating of perceived exertion.

The concurrent validity of Borg's RPE Scale ranged from .53 to .71, depending upon the amount of work load being used and the abilities of the participants.

The second measuring instrument used in the study consisted of a bicycle ergometer and heart rate monitoring system using a CM5 EKG lead. The bicycle ergometer was the vonDabeln-type (Monark). The heart rate monitoring system consisted of Narco-Bio Systems Oscillographic Recorder.

Procedure

The EMH students selected for the study were tested by the examiner and trained staff under identical conditions. The test protocol required that each subject start at 300 kpm/min and work at this particular work load for six minutes. During the last 30 seconds of the exercise bout the subject was asked to indicate the level of difficulty at which he thought he was working according to Borg's RPE scale. Throughout the test, the subject's heart rate was recorded on the Narco Bio-System equipment. When one exercise bout was completed, the subject rested for 10 minutes. Following the rest period, the work load was increased by 150 kpm/min and another bout was started after a second 10-minute rest. Work loads were established at 300, 450, and 600 kpm/min in order to produce heart rates of approximately 170 per minute. If the subject's heart rate exceeded 170 beats per minute, the test was terminated immediately and a perceived exertion rating was obtained.

Each subject was exposed to the same procedure until all had been tested. Approximately six subjects were tested per day with the total sample being tested within a 2-week period.

The data collected from the two groups of subjects were as follows:

1. Rate of Perceived Exertion (RPE) and Heart Rate (HR) at 300 kpm/min.

2. Rate of Perceived Exertion (RPE) and Heart Rate (HR) at 450 kpm/min.
3. Rate of Perceived Exertion (RPE) and Heart Rate (HR) at 600 kpm/min.

Data Analysis

In testing the null hypotheses it was necessary to compare the RPE scores of the successfully-employed and the unsuccessfully-employed student participants at each level of work exertion; 300 kpm/min, 450 kpm/min, and 600 kpm/min. It was also necessary to control the participants' heart rates as a covariable. The first three null hypotheses were tested by using a two-way analysis of covariance testing statistic with repeated measures on one factor.

The next three null hypotheses were tested by computing the RPE x HR correlations for the successfully-employed students and the unsuccessfully-employed students. A point-biserial correlation was computed for each of the coefficients.

In order to test the final three null hypotheses it was necessary to perform a linear transformation of the participants RPE and heart rate (HR) scores. The true ratio of the participants' RPE ratings to their heart rate was only partially reflected in the product moment correlation computed between the two. An alternative measure was calculated in order to give a more direct ratio of the RPE and HR data. This figure, which the experimenter called the "congruency index", was calculated by dividing

the heart rate (HR) by ten (10) and dividing the larger of the two numbers RPE/10 or HR into the smaller. For example, a RPE rating of 11 and a heart rate of 130 beats/min would be transformed as follows:

HR 130/10 = 13 RPE = 11

$$\text{Congruency Index} = \frac{HR/10}{RPE} \quad \text{or} \quad \frac{RPE}{HR/10}$$

with the smaller number being the numerator. In this instance the congruency index would be 11/13 = 0.846.

The RPE ratings and HR scores for both groups were converted to a congruency index for purposes of further analysis. The congruency indexes for each group at all three work load levels are presented in Appendix C.

In addition to considering the groups' congruency indexes, it was necessary to treat the participants' ages and I.Q. scores as covariables since these two factors could influence job success. Each groups' age and I.Q. data are presented in Appendix E.

The final three hypotheses were tested by performing a two-way analysis of covariance (ANCOVA) with the groups (successful and unsuccessful) and work loads (300, 450, and 600 kpm/min) as the two main effects and interaction between the two as the ninth null hypothesis.

# CHAPTER IV

## RESULTS OF DATA ANALYSIS

Rate of Perceived Exertion (RPE) ratings and heart rates of fifty (N = 50) EMH students enrolled in a high school work-study program were analyzed in order to determine if there was a difference between the perception/heart rate congruence of successfully-employed students and the perception/heart rate congruence of unsuccessfully-employed students. The experimenter utilized a bicycle ergometer, metronome, and a biological monitoring system to record the heart rates of twenty-five (N = 25) successfully-employed students and twenty-five (N = 25) unsuccessfully-employed students during 6-minute bouts at light (300 kpm/min), moderate (450 kpm/min), and heavy (600 kpm/min) work loads. Participants were asked to rate the amount of work they felt they were exerting during the final thrity seconds of each bout.

Nine null hypotheses were tested in the study. Three were related to differences between the two groups' perceptions at the three work load levels, three were concerned with comparing the two groups' RPE/HR relationships at the three work load levels, and three were stated to compare the groups' RPE/HR congruency indexes.

## Results of Testing Null Hypotheses One, Two and Three

The first three null hypotheses were stated and tested as follows:

$Ho_1$ There were no statistically significant differences between the mean rate-of-perceived-exertion (RPE) ratings made by the successfully-employed work-study students and the mean RPE ratings made by the unsuccessfully-employed work-study students.

$Ho_2$ There were no statistically significant differences among the mean rate-of-perceived-exertion (RPE) ratings made by participants at the light (300 kpm/min), moderate (450 kpm/min), and heavy (600 kpm/min) work load levels.

$Ho_3$ There was no statistically significant interaction between the independent variables of Group and Work-Load Level as reflected in the participants' rate-of-perceived-exertion (RPE) ratings.

The first three null hypotheses were tested by comparing the successful students' mean RPE ratings with the unsuccessful students' mean RPE ratings at all three work-load levels. The means and standard deviations of the groups and subgroups involved in the analysis are presented in Table 3.

The testing statistic for null hypotheses one, two, and three was a two way analysis of covariance with repeated measures on one variable. The participants' heart rates at each work-load level were treated as a covariate which controlled variations which may have occurred as the result of different levels of physical condition. Results of the

TABLE 3

MEANS AND STANDARD DEVIATIONS OF THE GROUPS' AND SUBGROUPS' RATE-OF-PERCEIVED-EXERTION (RPE) RATINGS WHICH WERE UTILIZED IN THE ANALYSIS OF VARIANCE AND COVARIANCE PROCEDURES

| | GROUPS | | |
|---|---|---|---|
| Work Load Levels | Successfully Employed | Unsuccessfully Employed | Work Load Totals |
| 300 kpm/min | $\overline{X}$ = 8.520<br>s = 1.610 | $\overline{X}$ = 11.800<br>s = 3.620 | $\overline{X}$ = 10.160<br>s = 3.228 |
| 450 kpm/min | $\overline{X}$ = 12.800<br>s = 1.350 | $\overline{X}$ = 12.520<br>s = 2.120 | $\overline{X}$ = 12.660<br>s = 1.768 |
| 600 kpm/min | $\overline{X}$ = 15.440<br>s = 1.710 | $\overline{X}$ = 14.280<br>s = 3.290 | $\overline{X}$ = 14.860<br>s = 2.657 |
| Group Totals | $\overline{X}$ = 12.250<br>s = 3.260 | $\overline{X}$ = 12.870<br>s = 3.210 | $\overline{X}$ = 12.560<br>s = 3.239 |

analysis of variance and covariance are presented in Table 4.

The data presented in Table 4 show that there was not a significant difference between the two groups' RPE ratings when heart rates (HR) were taken into account, $F(1, 47) = 0.885; p > .05$. These results allowed the researcher to accept the first null hypothesis.

The results of testing the second null hypothesis showed that there was not a significant difference among the RPE ratings made by participants at the three work-load levels, $F(2, 95) = 1.110; p > .05$. These results allowed the researcher to accept the second null hypothesis.

Results of testing the interaction hypothesis showed that there was not a significant interaction occurring between the two independent variables of Groups and Work-Load Levels. The low correlations of the RPE and HR measures had very little if any effect on the participants' adjusted scores. The results presented in Table 4 allowed the re- to accept the third null hypothesis.

TABLE 4

ANALYSIS OF VARIANCE AND COVARIANCE RESULTS COMPARING THE TWO GROUPS' RATE-OF-PERCEIVED-EXERTION (RPE) RATINGS WITH HEART RATES CONTROLLED AS A COVARIABLE

Analysis of Variance

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square | F-Value | Significance Level |
|---|---|---|---|---|---|
| BETWEEN SUBJECTS | | | | | |
| Groups | 14.107 | 1 | 14.107 | 1.280 | >.05 |
| Subj. Within Groups | 528.853 | 48 | 11.018 | | |
| WITHIN SUBJECTS | | | | | |
| Work Loads (B) | 553.000 | 2 | 276.500 | 1.110 | >.05 |
| AB Interaction | 138.730 | 2 | 69.365 | 0.279 | >.05 |
| B x (Subj. w. Gp.) | 23,907.27 | 96 | 249.030 | | |

Analysis of Covariance

| Source (Adjusted) | Sum of Squares | Degrees of Freedom | Mean Square | F-Value | Significance Level |
|---|---|---|---|---|---|
| BETWEEN SUBJECTS | | | | | |
| Groups (A) | 6.291 | 1 | 6.291 | 0.885 | >.05 |
| Subj. Within Groups | 334.076 | 47 | 7.108 | | |
| WITHIN SUBJECTS | | | | | |
| Work Loads (B') | 407.130 | 2 | 203.560 | 0.941 | >.05 |
| AB (Interaction) | 107.440 | 2 | 53.720 | 0.248 | >.05 |
| B x (Subj. w. Gp.) | 20,558.95 | 95 | 216.410 | | |

Results of Testing Null Hypotheses Numbers Four, Five and Six

The fourth, fifth, and sixth null hypotheses were stated and tested as follows:

$Ho_4$ There is no statistically significant correlation between the Rate-of-perceived-exertion and Heart-rate of successfully-employed work-study students and the RPE and HR of unsuccessfully-employed work-study students while performing a work load of 300 kpm/min.

$Ho_5$ There is no statistically significant correlation between the Rate-of-perceived-exertion and Heart-rate of successfully-employed work-study students and the RPE and HR of unsuccessfully-employed work study students while performing a work load of 450 kpm/min.

$Ho_6$ There is no statistically significant correlation between the Rate-of-perceived-exertion and Heart-rate of successfully-employed work-study students and the RPE and HR of unsuccessfully-employed work-study students while performing a work load of 600 kpm/min.

The fourth, fifth, and sixth null hypotheses were tested by computing correlation coefficients between the rate-of-perceived-exertion scores (RPE) and the heart rate (HR) scores of each group at all three work load levels. A biserial correlation technique was used to arrive at the coefficients. The correlation coefficients are presented in Table 5.

The data presented in Table 5 showed that there were no significant correlations among the groups' RPE x HR scores. These results allowed the researcher to accept the fourth, fifth, and sixth null hypotheses.

TABLE 5

CORRELATION OF THE RATE OF PERCEIVED EXERTION WITH HEART RATE FOR THE SUCCESSFUL GROUP AND UNSUCCESSFUL GROUP BY WORK LOAD

| Work Load | Successful Group | Unsuccessful Group |
|---|---|---|
| 300 KPM/MIN | $r = 0.136^a$ | $r = 0.270^a$ |
| 450 KPM/MIN | $r = -0.110^a$ | $r = 0.298^a$ |
| 600 KPM/MIN | $r = 0.099^a$ | $r = 0.179^a$ |

[a] not significant at .05 level

Results of Testing Null Hypotheses
Number Seven, Eight, and Nine

$Ho_7$ There is no statistically significant difference between the mean congruency indexes of the successfully-employed work-study group and the mean congruency indexes of the unsuccessfully-employed work-study group.

$Ho_8$ There are no statistically significant differences among the mean congruency indexes as computed for students working at the light, moderate, and heavy work loads.

$Ho_9$ There is no statistically significant interaction between the independent variables of Groups and Work-Load Levels as reflected in the participants congruency indexes at the light, moderate, and heavy work loads.

The seventh, eighth, and ninth null hypotheses were tested by computing a two-way analysis of covariance (ANCOVA) with the participants' age and I.Q. level being controlled as covariables. The means and standard deviations of the groups' and subgroups' RPE/HR congruency indexes are presented in Table 6. Results of the analysis of variance and ensuing covariance are presented in Table 7.

TABLE 6

MEANS AND STANDARD DEVIATIONS OF THE GROUPS' AND SUBGROUPS' CONGRUENCY INDEXES WHICH WERE UTILIZED IN THE ANALYSIS OF VARIANCE AND COVARIANCE PROCEDURES

| Work Load Levels | Group: Successfully Employed | Group: Unsuccessfully Employed | Totals (Work Loads) |
|---|---|---|---|
| 300 kpm/min | $\bar{X} = 0.756$<br>$s = 0.096$ | $\bar{X} = 0.793$<br>$s = 0.153$ | $\bar{X} = 0.775$<br>$s = 0.112$ |
| 450 kpm/min | $\bar{X} = 0.892$<br>$s = 0.069$ | $\bar{X} = 0.875$<br>$s = 0.101$ | $\bar{X} = 0.884$<br>$s = 0.077$ |
| 600 kpm/min | $\bar{X} = 0.888$<br>$s = 0.084$ | $\bar{X} = 0.830$<br>$s = 0.137$ | $\bar{X} = 0.859$<br>$s = 0.099$ |
| Totals (Group) | $\bar{X} = 0.844$<br>$s = 0.104$ | $\bar{X} = 0.833$<br>$s = 0.134$ | $\bar{X} = 0.839$<br>$s = 0.014$ |

TABLE 7

ANALYSIS OF VARIANCE AND COVARIANCE RESULTS COMPARING THE TWO GROUPS' RPE/HR CONGRUENCY INDEXES WITH AGE AND IQ CONTROLLED AS COVARIABLES

Analysis of Variance

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Square | F-Value | Significance Level |
|---|---|---|---|---|---|
| BETWEEN SUBJECTS | | | | | |
| Groups (A) | 3.988 | 1 | 3.988 | 4.302 | <.05 |
| Subj. Within Groups | 44.497 | 48 | 0.927 | | |
| WITHIN SUBJECTS | | | | | |
| Work Loads (B) | 350.500 | 2 | 175.250 | 26.639 | <.001 |
| AB Interaction | 2.276 | 2 | 1.138 | 0.173 | >.05 |
| B x (Subj. w. Gp.) | 1,512.86 | 96 | 6.579 | | |

Analysis of Covariance

| Source (Adjusted) | Sum of Squares | Degrees of Freedom | Mean Square | F-Value | Significance Level |
|---|---|---|---|---|---|
| BETWEEN SUBJECTS | | | | | |
| Groups (A) | 2.944 | 1 | 2.944 | 2.115 | >.05 |
| Subj. Within Groups | 65.424 | 47 | 1.392 | | |
| WITHIN SUBJECTS | | | | | |
| Work Loads (B') | 139.194 | 2 | 69.597 | 16.103 | <.01 |
| AB (Interaction) | 9.543 | 2 | 4.771 | 1.104 | >.05 |
| B x (Subj. w. Gp.) | 410.590 | 95 | 4.322 | | |

The data presented in Table 7 show that there was a significant difference between the Successful and Unsuccessful groups' congruceny indexes. However, when the covariates of age and IQ were taken into account, these results were eliminated $F(1,47) = 2.115; p > .05$. These results allowed the researcher to accept the seventh null hypothesis.

Table 7 also showed a significant difference among the congruency indexes at the three work-load levels, $F(2, 96) = 26.639; p < .001$. Even when the variables of age and IQ were taken into account, the results were still significant, $F(2, 95) = 16.103; p < .001$. Further comparisons among the means of the three work load levels showed that congruency indexes at the moderate and heavy work-load levels were significantly higher than indexes at the light work-load level. These results allowed the researcher to reject the eighth null hypothesis.

There was no significant interaction between the two variables of group or work-load level either before or after the covariates of age and IQ had been considered. These results allowed the researcher to accept the ninth null hypothesis.

## Summary of Results

Results of testing the hypotheses concerning the two groups' Rate-of-Perceived-Exertion (RPE) showed that there

were no significant differences among the groups' RPE ratings at any work-load level.

Correlations computed between the two groups' RPE and HR scores showed that there were no significant relationships among these variables.

Comparisons of the groups' RPE/HR congruency indexes showed that the indexes were significantly higher at the moderate and heavy work loads than at the light work load, but there was no significant difference between the two groups' indexes nor was there any significant interaction between the variables of group and work-load level.

# CHAPTER V

## SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER RESEARCH

The purpose of this study was to investigate differences between the perceived exertion ratings (RPE) and heart rate (HR) of successfully-employed EMH students and unsuccessfully-employed EMH students in a high school work-study program. Fifty (N=50) male EMH students enrolled in the work-study programs offered by five central Oklahoma public school systems acted as subjects in the study.

The experimenter utilized a bicycle ergometer, and an EKG monitoring system to record the heart rates of twenty-five (N=25) successfully-employed students and twenty-five (N=25) unsuccessfully-employed students during 6-minute bouts at light (300 kpm/min), moderate (450 kpm/min) and heavy (600 kpm/min) work loads. Participants were asked to rate the amount of work they felt they were exerting during the final thirty seconds of each bout according to Borg's RPE scale.

Nine null hypotheses were tested in the study. Three were related to differences between the two groups' perceptions at the three work load levels, three were concerned with comparing the two groups' RPE/HR relationships at the three work load levels, and three were tested to compare

the two groups' RPE/HR congruency indexes.

Results of testing the hypotheses concerning the two groups' Rate of Perceived Exertion (RPE) showed that there were no significant differences among the groups' RPE ratings at the light (300 kpm/min), moderate (450 kpm/min), or heavy (600 kpm/min) work loads.

Coorelations computed among the two groups' RPE and HR scores showed that there were no significant relationships between these variables.

Comparisons of the groups' RPE/HR congruency indexes showed that the indexes were significantly higher at the moderate and heavy work loads than at the light work load, but there was no significant difference between the successful and unsuccessful group's indexes nor was there any significant interaction between the two independent variables of Group or Work-Load Level (A x B).

## Conclusions

The conclusions presented in this section are the major conclusions which could be defensibly drawn from the results obtained from testing the hypotheses. The generalization of the results obtained in the present study to other populations of students should be approached with caution until more research has been conducted in the area.

The results of testing the first three hypotheses led to the conclusion that the unsuccessfully-employed students

rated the three work loads much the same as the successfully-employed students. The results of the analysis of variance indicated the unsuccessful group saw the light work load as being much more difficult than the successful students. When the analysis of covariance was applied using heart rate as a variable, the significance was reduced to the level of no difference.

The results of testing the fourth, fifth, and sixth null hypotheses led to the conclusion that there was no real relationship between the participants' RPE scores and their heart rates.

Results of testing the seventh, eighth, and ninth null hypotheses led to the conclusion that the participants were much better able to judge how hard they were working at the moderate and heavy work loads than at the light work-load level.

Able (1940) determined work success was dependent upon the proper placement of students in a work situation that met their unique psychological needs and comparable to the physical abilities. The near significance of the first hypothesis could lead one to speculate that the unsuccessful students viewed the light work load as much more difficult than the successful students. RPE ratings of the initial work experience on the job could then be misleading since the analysis of covariance indicated that there are no

differences in the successful and unsuccessful groups. This would cause one to speculate that the difference at the light work load was more of a result of the students not knowing what to expect or unknown psychometric factors rather than actual perception of heart rate. This observation during actual job situations was the reason for developing the study. Casual observation of the RPE rating at the three work loads could appear to mirror the actual job placement and retention difficulties. Research (Skinner, 1973) does not support this observation when it was determined that RPE was not significantly different when different work loads were randomly administered. This indicated that something different than initial work load is resulting in significant difference at the light work load. Further research is necessary to determine difference.

In a normal population, the average correlation between RPE and heart rate has been reported to approximate .82, this means that about 32 percent of the variance remains unexplained. The results of the fourth, fifth, and sixth hypotheses demonstrates that approximately 85 per cent variance in the EMH work-study population remains unexplained. Research has reported that perceived exertion was not influenced by aerobic power, body composition, or physical training (Borg, 1962). Therefore, the unexplained variance may possibly be dependent upon psychometric factors. These results would not support the use of the

RPE/HR rating scale to differentiate between successful and unsuccessful EMH work-study student.

The results of the seventh, eighth, and ninth hypotheses also indicates that the light work load was significantly different from the moderate and heavy work load when rating the perceived difficulty by EMH work-study students. Apparently the difference is psychometric and not a result of the rating instrument.

## Implications for Further Research

Prior research has viewed perceived exertion as a psychological process. The prior research has attempted to examine the juxtaposition of subjective self reports and physiologic responsitivity. This investigator feels that since the RPE of EMH work-study students did not compare in any of the areas with normally reported results of RPE rating, further investigation will be necessary. In addition to the replication of the study, an interaction of psychometric variables should be studied. Specifically, the addition of introversion-extroversion ratings, overt aggression scales, depression scales, and a personality inventory. Since many of the mentioned tests have reading levels that may not appropriate to the EMH students, pilot studies should be conducted to determine most appropriate needs of EMH students.

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# APPENDIX A

## Correspondence Sent to Teacher/Coordinators at the Participating School Systems

Dear Teacher Coordinator:

Enclosed is a rating sheet to be used in connection with a research project being conducted at the University of Oklahoma. All of the information will be kept confidential and the students will be referred to only by numbers in the study.

Do NOT include any of the following students:

1. ninth grade students
2. those who have been in the program for less than 9 weeks
3. any student who is not physically able to work
4. any student not capable of pedaling a bicycle

After determining those students who are to be used in this survey, please list your students in descending order, the most successful worker to the least successful worker in your program. When rating these students, keep the following criteria in mind:

Social Adjustment Criteria

1. Self-confidence
2. Cheerfulness
3. Cooperation with supervisor
4. Cooperation with fellow-employees
5. Respects authority
6. Minds own business
7. Accepts criticism
8. Mixes socially with employees
9. Nest and clean

Work Habit Criteria

1. On time
2. Careful of materials
3. Completes work on time
4. Work is of good quality
5. Understands work
6. Shows initiative

When you have finished rating your Work-Study students, please return the rating form in the enclosed, self-addressed stampled envelope. Your cooperation and effort will help to provide data with which to better evaluate the psychological needs of your students. Thank you for your cooperation.

Sincerely yours,

James A. Van Zant

# APPENDIX B

## Borg's Rate of Perceived Exertion Scale (Modified)

## Borg's Rate of Perceived Exertion Scale

6

7 Very, very light

8

9 Very light

10

11 Fairly light

12

13 Somewhat hard

14

15 Hard

16

17 Very hard

18

19 Very, very hard

# APPENDIX C

## RPE/HR Congruency Indexes Computed for Individual Participants

TABLE 8

CONGRUENCY INDICES* COMPUTED FOR THE SUCCESSFULLY-EMPLOYED PARTICIPANTS AT ALL THREE WORK LOAD LEVELS

| Subject Number | 300 kpm/min | 450 kpm/min | 600 kpm/min |
|---|---|---|---|
| 1 | 0.692 | 0.897 | 0.909 |
| 2 | 0.636 | 1.000 | 0.906 |
| 3 | 0.727 | 0.923 | 0.962 |
| 4 | 0.778 | 0.880 | 0.967 |
| 5 | 0.778 | 0.846 | 0.706 |
| 6 | 0.609 | 0.867 | 0.853 |
| 7 | 0.818 | 0.963 | 0.929 |
| 8 | 0.750 | 0.897 | 0.941 |
| 9 | 0.818 | 1.000 | 0.934 |
| 10 | 0.818 | 0.889 | 0.968 |
| 11 | 0.800 | 0.846 | 0.967 |
| 12 | 0.889 | 0.885 | 0.706 |
| 13 | 0.783 | 0.900 | 0.853 |
| 14 | 0.900 | 1.000 | 0.897 |
| 15 | 0.800 | 0.857 | 0.848 |
| 16 | 0.600 | 0.963 | 0.966 |
| 17 | 0.820 | 0.889 | 0.967 |
| 18 | 0.842 | 0.880 | 0.933 |
| 19 | 0.600 | 0.846 | 1.000 |
| 20 | 0.609 | 0.867 | 0.853 |
| 21 | 0.818 | 1.000 | 0.853 |
| 22 | 0.800 | 0.867 | 0.882 |
| 23 | 0.800 | 0.710 | 0.895 |
| 24 | 0.783 | 0.844 | 0.778 |
| 25 | 0.600 | 0.786 | 0.727 |
| Mean | 0.756 | 0.892 | 0.888 |
| Standard Deviation | 0.096 | 0.069 | 0.084 |

TABLE 9

CONGRUENCY INDICES* COMPUTED FOR THE UNSUCCESSFULLY-EMPLOYED PARTICIPANTS AT ALL THREE WORK LOAD LEVELS

| Subject Number | 300 kpm/min | 450 kpm/min | 600 kpm/min |
|---|---|---|---|
| 1 | 1.000 | 1.000 | 0.825 |
| 2 | 0.870 | 0.786 | 0.788 |
| 3 | 0.680 | 0.962 | 0.884 |
| 4 | 0.813 | 0.933 | 0.971 |
| 5 | 0.462 | 0.815 | 0.353 |
| 6 | 0.956 | 0.867 | 0.971 |
| 7 | 0.929 | 0.690 | 0.788 |
| 8 | 0.719 | 0.963 | 0.917 |
| 9 | 0.813 | 0.933 | 0.971 |
| 10 | 0.750 | 0.889 | 0.765 |
| 11 | 0.769 | 0.759 | 0.882 |
| 12 | 0.917 | 1.000 | 0.966 |
| 13 | 0.958 | 0.963 | 0.897 |
| 14 | 0.864 | 0.960 | 0.828 |
| 15 | 0.500 | 0.692 | 0.774 |
| 16 | 0.778 | 0.968 | 0.882 |
| 17 | 0.500 | 0.800 | 0.529 |
| 18 | 0.870 | 0.846 | 0.848 |
| 19 | 0.917 | 0.667 | 0.774 |
| 20 | 0.864 | 0.833 | 0.774 |
| 21 | 0.783 | 0.813 | 0.906 |
| 22 | 0.545 | 0.923 | 0.828 |
| 23 | 0.800 | 0.964 | 0.909 |
| 24 | 0.800 | 0.967 | 0.825 |
| 25 | 0.956 | 0.889 | 0.897 |
| Mean | 0.793 | 0.875 | 0.830 |
| Standard Deviation | 0.153 | 0.101 | 0.137 |

# APPENDIX D

## Rate of Perceived Exertion Ratings and Heart Rates of Individual Participants

TABLE 10

PERCEIVED RATE OF EXERTION AND HEART RATES OF THE SUCCESSFULLY-EMPLOYED PARTICIPANTS

| Subject Number | Work Load | | | | | |
|---|---|---|---|---|---|---|
| | 300 kpm/min | | 450 kpm/min | | 600 kpm/min | |
| | RPE | HR | RPE | HR | RPE | HR |
| 1. | 9 | 130 | 13 | 145 | 15 | 165 |
| 2. | 7 | 110 | 13 | 130 | 16 | 145 |
| 3. | 8 | 110 | 12 | 130 | 15 | 145 |
| 4. | 7 | 90 | 11 | 125 | 15 | 145 |
| 5. | 7 | 90 | 13 | 110 | 17 | 120 |
| 6. | 7 | 115 | 15 | 130 | 17 | 145 |
| 7. | 11 | 90 | 13 | 135 | 13 | 140 |
| 8. | 9 | 120 | 13 | 145 | 16 | 170 |
| 9. | 9 | 110 | 13 | 130 | 16 | 150 |
| 10. | 9 | 110 | 12 | 135 | 15 | 155 |
| 11. | 8 | 100 | 11 | 130 | 15 | 145 |
| 12. | 8 | 90 | 13 | 115 | 17 | 120 |
| 13. | 9 | 115 | 15 | 135 | 17 | 145 |
| 14. | 10 | 90 | 13 | 130 | 13 | 145 |
| 15. | 10 | 125 | 12 | 140 | 14 | 165 |
| 16. | 6 | 100 | 13 | 135 | 14 | 145 |
| 17. | 10 | 115 | 12 | 135 | 15 | 145 |
| 18. | 8 | 95 | 11 | 125 | 15 | 140 |
| 19. | 6 | 100 | 13 | 110 | 13 | 130 |
| 20. | 7 | 115 | 15 | 130 | 17 | 145 |
| 21. | 11 | 90 | 13 | 130 | 17 | 145 |
| 22. | 10 | 125 | 13 | 150 | 15 | 170 |
| 23. | 10 | 125 | 11 | 155 | 19 | 170 |
| 24. | 11 | 95 | 16 | 135 | 18 | 140 |
| 25. | 6 | 100 | 11 | 140 | 12 | 165 |
| Mean | 8.36 | 106.20 | 12.80 | 131.80 | 15.44 | 147.80 |
| Standard Deviation | 1.78 | 13.17 | 1.35 | 10.09 | 1.71 | 13.78 |

TABLE 11

PERCEIVED RATE OF EXERTION AND HEART RATES OF THE UNSUCCESSFULLY-EMPLOYED PARTICIPANTS

| Subject Number | Work Load | | | | | |
|---|---|---|---|---|---|---|
| | 300 kpm/min | | 450 kpm/min | | 600 kpm/min | |
| | RPE | HR | RPE | HR | RPE | HR |
| 1. | 11 | 110 | 15 | 130 | 20 | 165 |
| 2. | 15 | 130 | 11 | 140 | 13 | 165 |
| 3. | 17 | 115 | 13 | 125 | 19 | 168 |
| 4. | 16 | 130 | 15 | 140 | 17 | 165 |
| 5. | 6 | 130 | 11 | 135 | 6 | 170 |
| 6. | 11 | 115 | 15 | 130 | 17 | 165 |
| 7. | 14 | 130 | 10 | 145 | 13 | 165 |
| 8. | 16 | 115 | 13 | 135 | 18 | 165 |
| 9. | 16 | 130 | 15 | 140 | 17 | 165 |
| 10. | 9 | 120 | 12 | 135 | 13 | 170 |
| 11. | 10 | 130 | 11 | 145 | 15 | 170 |
| 12. | 12 | 110 | 13 | 130 | 14 | 145 |
| 13. | 12 | 115 | 13 | 135 | 13 | 145 |
| 14. | 11 | 95 | 12 | 125 | 12 | 145 |
| 15. | 6 | 120 | 9 | 130 | 12 | 155 |
| 16. | 18 | 140 | 15 | 155 | 15 | 170 |
| 17. | 6 | 120 | 12 | 150 | 9 | 170 |
| 18. | 10 | 115 | 11 | 130 | 14 | 165 |
| 19. | 12 | 110 | 8 | 120 | 12 | 155 |
| 20. | 11 | 95 | 10 | 120 | 12 | 155 |
| 21. | 9 | 115 | 16 | 130 | 16 | 145 |
| 22. | 6 | 110 | 12 | 130 | 12 | 145 |
| 23. | 15 | 120 | 14 | 135 | 15 | 165 |
| 24. | 15 | 120 | 15 | 145 | 20 | 165 |
| 25. | 11 | 115 | 12 | 135 | 13 | 145 |
| Mean | 11.80 | 118.20 | 12.52 | 134.80 | 14.28 | 159.92 |
| Standard Deviation | 3.62 | 10.69 | 2.12 | 8.72 | 3.29 | 9.45 |

# APPENDIX E

## Demographic Data of Individual Participants

TABLE 12

DEMOGRAPHIC INFORMATION CONCERNING THE SUCCESSFULLY-EMPLOYED E M H STUDENTS

| Subject | Sex | Race | Age | I.Q. |
|---|---|---|---|---|
| 1 | M | W | 18 | 73 |
| 2 | M | W | 18 | 74 |
| 3 | M | W | 17 | 71 |
| 4 | M | W | 17 | 76 |
| 5 | M | W | 18 | 73 |
| 6 | M | W | 17 | 73 |
| 7 | M | W | 17 | 68 |
| 8 | M | B | 18 | 77 |
| 9 | M | W | 18 | 76 |
| 10 | M | W | 18 | 74 |
| 11 | M | W | 17 | 71 |
| 12 | M | W | 17 | 73 |
| 13 | M | W | 18 | 78 |
| 14 | M | W | 18 | 76 |
| 15 | M | W | 18 | 69 |
| 16 | M | B | 16 | 73 |
| 17 | M | B | 16 | 76 |
| 18 | M | W | 17 | 74 |
| 19 | M | W | 18 | 72 |
| 20 | M | W | 18 | 73 |
| 21 | M | W | 18 | 68 |
| 22 | M | W | 17 | 75 |
| 23 | M | W | 17 | 76 |
| 24 | M | W | 17 | 74 |
| 25 | M | W | 16 | 71 |
| Mean | | | 17.24 | 73.4 |

TABLE 13

DEMOGRAPHIC INFORMATION CONCERNING THE UNSUCCESSFULLY-EMPLOYED E M H STUDENTS

| Subject | Sex | Race | Age | I.Q. |
|---|---|---|---|---|
| 1 | M | W | 17 | 68 |
| 2 | M | W | 16 | 73 |
| 3 | M | W | 16 | 74 |
| 4 | M | W | 17 | 74 |
| 5 | M | B | 16 | 66 |
| 6 | M | B | 17 | 73 |
| 7 | M | W | 16 | 72 |
| 8 | M | W | 17 | 68 |
| 9 | M | W | 15 | 72 |
| 10 | M | W | 15 | 68 |
| 11 | M | W | 17 | 73 |
| 12 | M | W | 17 | 67 |
| 13 | M | W | 16 | 70 |
| 14 | M | W | 17 | 73 |
| 15 | M | W | 16 | 73 |
| 16 | M | W | 16 | 67 |
| 17 | M | W | 16 | 70 |
| 18 | M | W | 16 | 74 |
| 19 | M | W | 17 | 74 |
| 20 | M | W | 17 | 74 |
| 21 | M | W | 17 | 70 |
| 22 | M | W | 16 | 69 |
| 23 | M | W | 17 | 70 |
| 24 | M | W | 15 | 72 |
| 25 | M | W | 17 | 72 |
| Mean | | | 16.36 | 68.36 |