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ABSTRACT

Achievement in earning grades in high school was resolved into its intellectual and motivational components. This study employed tests of I.Q., personality inventories and classical and operant conditioning of autonomic nervous system controlled variables. Eleven procedures were given to 99 Black inner city high school seniors. Six physiological variables were analyzed directly on a computer using analog-to-digital conversion and programs which identified and summarized all responses and recoveries to the tones and pain stimuli of the classical conditioning and those during the operant conditioning using analog biofeedback of heart rate. Achievement (ACH) was defined as the residuals of average total grade point average (GPA) regressed on I.Q. Both ACH and GPA were examined as to their components. Results of regression analyses showed that 50.89% of the variance of GPS was accounted for by I.Q. 20.44%, Edwards Personality Inventory 9.08%, operant conditioning 18.70%, and classical conditioning 2.6%. Findings from this study appear to justify the conclusions that for this population of students, the measures of motivation account for 30.45% of the variance whereas I.Q. accounts for only 20.46% of the variance in grades. (Author/MLP)

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THE CONTRIBUTION OF LIMBIC LEARNING APTITUDE TO ACHIEVEMENT IN HIGH SCHOOL

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SUMMARY

Achievement in earning grades in high school was resolved into its intellectual and motivational components. Based on previous studies of social achievements of various kinds this study employed tests of I.Q., personality inventories and classical and operant conditioning of autonomic nervous system controlled variables. Over a two day period for each subject these eleven procedures were given to 106 Black inner city high school seniors of which the data for 99 subjects were suitable for analysis.

The six physiological variables (respiration, heart rate, finger plethysmogram, frontalis muscle potential, palmar skin conductance and palmar skin potential) were analyzed directly on a computer using analog-to-digital conversion and programs developed by the authors which identified and summarized all responses and recoveries to the tones and pain stimuli of the classical conditioning and those during the operant conditioning using analog biofeedback of heart rate.

Achievement (ACH) was defined as the residuals of average total grade point average (GPA) regressed on I.Q. (full WAIS). Both ACH and GPA were examined as to their components.

By 9 factor analyses, high and low achievement group comparisons, correlations with ACH and GPA a final set of 19 significant variables were employed in step-wise regression and discriminant function analyses for GPA and ACH separately.

Results of these regression analyses showed that 50.89% of the variance of GPA was accounted for by I.Q. (20.44%), Edwards Personality Inventory (9.08%), operant conditioning (18.70%), and classical conditioning (2.67%). The discriminant function analysis for GPA correctly predicted 84.84% of the 99 subjects into their correct criterion groups. The regressions for ACH accounted for 41% of the variance similarly proportioned.

Findings from this study appear to justify the conclusions that for this population of students, the measures of motivation account for 30.45% of the variance whereas I.Q. accounts for only 20.46% of the variance in grades. Since the physiological measures are applicable, before school or even before language is available, it is suggested that these physiological measures of motivational and emotional learning aptitude should be examined in prospective studies to determine their efficacy in identifying preschool children as to their achievement potentials. With such knowledge in hand more appropriate expectations and facilitative educational procedures could be instituted at the most opportune times for maximum success.

This study, and future ones suggested, it is hoped, also advance the theory of human motivation and point to some of its mechanisms and approaches to its further study.

PROBLEM AND OBJECTIVES

The underachiever constitutes a severe problem for education and for our society. A major study (Impellizzeri, Barr, and Cooney, 1965) found that about 12% of the 40,000 high school students in the New York City schools were of superior ability but nearly half of these could be identified as underachievers in terms of their school grades. Others estimate that up to 10% of students are performing substantially below their I.Q. or school aptitude test results. Most writers on the problem agree that underachievement is a genuine phenomenon and not merely due to the unreliability of the two distributions involved (grades and I.Q.). The basis for this confidence in the construct of underachievement is the fact that it is very easy to detect difficulties among the underachievers when compared to control groups of normal achievers. These difficulties cover the range of human failure including all types of neurosis, character and personality disorder, family disharmony and lack of parental incentives, low socio-economic status, low motivation and lack of environmental incentives. One way to look at underachievement is to recognize that school is the main serious work of children and hence any behavioral inefficiency or impairment would be expected to reveal itself in some aspect of school achievement. Still another viewpoint is that proposed by Schwitzgebel (1965) who suggests that instead of speaking of underachievement we call it over prediction. The notion here is that achievement in school requires abilities other than I.Q. or that which is currently measured by school achievement tests. We simply have failed to measure relevant aptitudes, thus in many cases mistakenly label the child as having good school aptitude whereas in reality he lacks some essential characteristics. We propose that this is a much more realistic and helpful attitude, because it impels us to look further into the abilities of the child rather than blaming him or society for somehow being bad. We have oversold ourselves on I.Q. as the essential and sufficient prerequisite for school achievement. Rubin and Braun (1968) studied several hundred grade school children comparing those who were having trouble in school with those doing well. With a special battery of cognitive-motor dysfunction tests they found that about 40% of those in trouble had cognitive-motor dysfunction but without depressed I.Q. This suggests that the other 60% of those doing poorly in school without depressed I.Q. must have some other problem. We propose that the problem may involve psychophysiologic aspects of motivation. Clearly, to achieve many abilities are required and many deficiencies or faults must be absent. The problem is to describe each child's particular abilities and faults so as to enable corrective measures to be taken. This needs to be done very early, preferably before the child begins school. Once he accumulates experience of failure, the correction is all the more difficult. One study (Shaw and McCuen, 1965) found that underachieving high school boys had been consistently underachieving since the first grade. More often girls begin their underachievement with puberty at about grade six.

The very promising work that McClelland and Alschuler (1967-68) are doing at Harvard on the Achievement Motivation Development Project shows that the achievement motive can be taught and often results in substantial increases in performance. This pioneer work will no doubt have profound influence on teaching methods and will probably become even more effective

when applied to younger people. It is also very clear from their reports that there are very wide individual differences in the extent to which this special motivation training results in improved performance. No very convincing explanation has been offered for this great variability in learning achievement motivation. We propose that learning the social motives, including the achievement motive, requires special abilities.

Previous experiments (Ax and Bamford, 1968, and Ax, Bamford, Beckett, Fretz and Gottlieb, 1970) have found evidence for one such aptitude and have demonstrated that it can be measured. We view the aptitude for learning motivation as a logical necessity which follows from the statement that motives are learned. Nearly all modern writers on motivation assert that motives are learned (McClelland, Atkinson, Clark, and Lovell, 1953; Cofer and Appley, 1964). For every learned behavior, it is necessary that the individual possess the aptitude for such learning whether it be athletic, musical, intellectual or motivational. The controversial point is the extent to which a general aptitude serves many kinds of behavior versus the viewpoint that the aptitude may be rather specific to particular behavior. Guilford (1967) has demonstrated convincingly that quite specific aptitudes can be differentiated even within the general intellectual category. On the other hand it has also been shown (Spearman, 1932) that there is usually a low to moderate correlation among abilities suggesting that there is also some generality. As with so many controversies in psychology, it is probably true that both general and specific aptitudes are useful concepts. Within one broad category like intelligence, the specific aptitudes such as numerical, verbal, reasoning, memory, etc. probably have a fairly substantial common core which Spearman called general intelligence. The more disparate aptitudes such as physical athletic aptitude, musical talent, I.Q. and emotional learning aptitude are probably essentially uncorrelated. At least our findings were that the autonomic conditioning measure of emotional learning aptitude is uncorrelated with I.Q.

Earlier we spoke of the aptitude for learning motivation, but now we equate it to the aptitude for emotional learning. Since we are measuring the learning rate of physiological processes under control of the limbic nervous system, it seems correct to speak of the aptitude for emotional learning. However, it is our thesis that the same aptitude is involved in motivation.

We have completed two studies which provide evidence for the construct of an aptitude for motivational learning. The first study (Ax, et al. 1970) was a classical conditioning study of autonomic variables in chronic schizophrenic and healthy control groups. The variables studied were palmar sweating (GSR) and finger plethysmogram. The conditional stimuli were three tones each of a different pitch. The two higher-pitched tones were paired each 10 times with one of two different intensities of pain. The lower-pitched tone was never paired with the pain. The 28 chronic schizophrenic patients constituted a group studied over several years by the research labs of The Lafayette Clinic (Gottlieb, J. S. & Tourney, G., Eds. 1970) and were kept on a good diet, required to exercise daily and were

off all drugs for several years. They all were clearly chronic schizophrenics as agreed upon by three psychiatrists who studied them for several years. The control group were 18 healthy staff members and students matched for age to the patients.

The main findings were that the patients responded normally to the pain stimulus with their ANS. They showed somewhat reduced amplitude of the orienting responses to the tones before habituation. The most striking finding was the drastically impaired conditional responses to the tones that had been paired with the pain. Since this was clearly a learning task for the autonomic nervous system we interpreted these results as evidence for a reduced aptitude for emotional learning. As do all chronic schizophrenic patients these subjects manifested inappropriate and reduced affect, lack of emotional control, and certainly were much impaired in the normal social motives. Thus clinically they presented the symptoms that were compatible with the hypothesis of reduced or impaired aptitude for emotional learning. By this experiment alone, we could not prove that this impairment in emotional learning played any role in the etiology of their illness. Some characteristics of the illness might be causing the poor conditioning.

We thought that if we could find people who were not schizophrenic but had a life history manifesting very low social motivation, they could test our hypothesis of relationship between poor emotional learning and low motivation. After much effort we finally persuaded a few skid row habitués to come into the hospital for two weeks during which they were given physical, neurological, and psychiatric examination. If all three examinations were negative, they were then given the conditioning test. Three met the criteria and were tested. All were as severely impaired in autonomic conditioning as were the chronic schizophrenic patients. These findings we think at least suggest that there may possibly be a relationship between impaired autonomic conditioning and low motivation. We readily admit, however, that three subjects were too few for confidence. Then, too, there may be something in the life pattern of skid row habitué which tends toward poor performance on a conditioning task as it is possible to argue for the schizophrenic patients.

Next we (Ax and Bamford, 1968) studied a younger group of school dropouts and other persons most of whom were attending a special vocational retraining school called the Detroit Skills Center. We had learned that about 50% of such students were able to profit from the school and get and hold jobs and become self sustaining; whereas, the other half seemed not able to profit by the school. We asked the teachers of the Skills Center School whether they felt they could distinguish between those who were well motivated and those who seemed poorly motivated. The teachers felt they could distinguish between the two types. Our hypothesis was that some school dropouts and other chronically unemployed had reached this state because of poor family incentives, unfortunate school and health experiences, etc., but may have a normal endowment of aptitude for learning social motives. These should do well in the permissive and helpful Skills Center atmosphere. On the other hand if a person really lacked the aptitude for emotional learning he would acquire motivation much more slowly and would thus certainly come to the attention

of the teachers. These students who were low in emotional learning aptitude might also be expected to have more neurotic and other evidences of emotional immaturity.

A group of 32 were selected who were judged to be relatively higher in motivation by their teachers and by their case histories; and a group of 31 were selected who were judged to be relatively lower in motivation. These 63 subjects were given a simplified version of the autonomic conditioning test and several other psychological tests. The findings support our hypothesis very well. Eighteen scores, which included 10 physiological and conditioning scores, each discriminated significantly between the two groups. When these 18 discriminating scores (from a total of 51, with less than three expected to be significant by chance) were combined into a discriminant function analysis, it correctly identified 92% of the 63 subjects as to criterion group. In addition to this strong support of our major hypothesis that impairment in autonomic conditioning is associated with a life history of low social motivation, there were several interesting interrelationships among the variables. There was no correlation between I.Q. and autonomic conditioning. Thus it is clear that the conditioning variable is tapping an aptitude different from intellectual aptitude. Subjects who became aware of the contingency between the tone and the pain gave larger conditioning scores; but these aware subjects were about equally distributed between high and low motivation groups, showing that awareness could not be responsible for the discrimination. When the aware and unaware groups data were treated separately, it was found that the physiological conditioning scores of each group separately still discriminated significantly between the high and low motivation groups. In fact awareness made the discrimination between high and low motivation groups better.

Several psychological tests also discriminated significantly between the two criterion groups. The level of aspiration test required the subject to estimate his score just before performing the task. The task consisted of pushing a steel ball with a cue stick attempting to get the ball to stop in the middle of 20 holes thus gaining the top score of 10. Consistent over-estimation would be counted as a high level of aspiration. This level of aspiration score, however, did not discriminate the groups. Another level of aspiration score (Ax, 1946), called the judgment error score which totalled the error in estimates disregarding the sign, did discriminate -- the low motivation group earning the higher error score. Some of these low motivation subjects consistently over-estimated, some under-estimated, and some fluctuated from over- to under-estimating. We are unsure whether this judgment error score relates to low aptitude for motivation, but it surely relates to poor performance in school and life's work.

Three of the scales of the 16-Personality Factor Questionnaire discriminated significantly. These were Scale G - conscientiousness, perseverance (high gp), L - suspiciousness (low gp), and M - imagination (high gp). Interestingly the other scales relating to personality and neurotic trends did not discriminate. Nor did either of two anxiety scales detect any difference between groups. Thus we feel confident, the groupings were not primarily based on neurosis.

On intelligence tests, the high motivation group scored significantly higher (99.0 vs. 87.6) than did the low group. Since intelligence tests measure what has been learned they surely measure motivation as well as intelligence. It was expected on this basis that high and low motivation groups would score differently on I.Q. The zero order correlation between our physiological conditional measures and I.Q. provide evidence that our two criterion groups were not merely different on I.Q., but it is also probably true that the rating teachers, although instructed to select on motivation only, may have been somewhat influenced by performance which would of course be a joint function of intelligence and motivation.

Why should classical conditioning of such variables as palmar sweating, heart rate and vascular constriction relate to the aptitude for social motivation? We believe the explanation is straightforward. Social motivation is mediated by the emotional nervous system (limbic (LS) and autonomic (ANS) systems). Classical conditioning of such LS and ANS variables measures the learning rate of the system. Since an aptitude is defined by the learning rate of the systems involved, the conditioning rate would appear to be a direct measure of the aptitude for motivational learning. Classical conditioning has another advantage because it is relatively free from the confounding factor of subject cooperation, understanding of instructions, etc.

In our two previous studies we found the conditioning procedure to produce results which correlated well with ratings of achievement. In this current study we also have attempted to study the strength of the achievement motive as it is already developed in each subject. Although there will tend to be some correlation between the aptitude for learning motivation and current strength of a particular motive, it will be far from a perfect correlation. As with other aptitudes, there will be some individuals who have a high aptitude for learning motivation who will not have had the opportunitity to have developed a strong achievement motive. These people would rapidly develop motivation if given the incentive and opportunity such as might be provided by a good vocational school. Others who have little aptitude for learning motivation would not benefit much by such opportunities. Those with a strong achievement motive already developed will not be school dropouts nor underachievers. They may vary greatly in amount achieved due to other aptitudes and opportunities as well as the realism of their hierarchy of motives.

The objectives of this study, then, were to describe and measure the achievement motive and the aptitude for learning motivation in two groups of high school seniors: (1) those described as underachievers and (2) those who have demonstrated a strong achievement motive. The ultimate objective of this type of research is to bring better understanding of the causes of underachievement and to develop tests which can distinguish between those underachievers who are merely lacking in a proper achievement motive but who have the basic aptitude to develop motivation and those whose low motivational aptitude will require special procedures and can only be expected in their present state to develop a modicum of achievement motive. Being able to identify these two types of underachievers at an early age will enable more effective and economical educational procedures. Our goal for motivational aptitude is analogous to the development of tests for intelligence so that those differing in

motivational aptitude may be detected early and more appropriate educational opportunities provided for them.

This is an application of psychophysiology to education. Up to now education has dealt chiefly with the cognitive aspects of development with the emotional and motivational aspects largely ignored except when difficulties arose. With adequate research sophisticated methods can be applied to deal with these very important emotional and motivational aspects of development.

In addition to the practical aspects of this study it has relevance to motivation theory. While it is generally agreed that human motives are learned (Cofer and Appley, 1964; McClelland, 1965a, 1965b), there is probably less agreement that a specific aptitude can be identified for the learning of motives. Our previous study (Ax and Bamford, 1968) suggests that an aptitude independent of I.Q. apparently exists which we have tentatively named the aptitude for emotional learning. The aptitude would relate to more than the learning of motives. It would underlie all aspects of emotional development. As with other aptitudes such as I.Q. or musical talent, it is probably a combination of genetic endowment and environmental stimulation. This study makes no attempt to evaluate the relative contributions of heredity and environment.

METHOD

1. Subjects.

Subjects were 106 Negro seniors of Eastern High School -- a central city school of Detroit, Michigan. These subjects were selected by our Black psychologist interviewer. He obtained full cooperation of the principal, assistant principal and counselors. Grades for 2 or 3 years, the SCAT scores when available and the advice of the counselor were utilized in selecting the subjects. The goal was to have about 65 probable underachievers defined tentatively as grades below their expected grade as predicted by the SCAT, and about 35 high or over achievers defined as having grades equal or above SCAT predicted values. Since our experimental design required no exact proportions of high and low achievers, and because the definition of high and low achievement would have to be finally defined after testing in our laboratory, we did not specify or demand any rigorous limits on grades or SCAT scores for the students selected as subjects.

Since a substantial portion of these subjects were selected because they were showing poor school motivation, there was a built-in problem of gaining their cooperation. Of course there were many students contacted who did not participate, so that, the very poorest motivated of the underachievers were probably not included in this study which is bound to attenuate to some unknown extent our findings.

2. Procedures.

Each student contacted was told the purpose of the tests and that he would be paid $2.00/hr. or about $24 total if he completed the tests. Half of his first day's pay was held back pending his completion on the second day. He was given a permission form for his parent to sign (see appendix).

a. Testing

The tests were administered in the following order and times:

First Day:

8:00 Subject picked up by Clinic car and brought to Clinic

8:30 LEVEL OF ASPIRATION TEST is a test which consists of an alley with numbered depressions, the middle one being the target into which the subject attempts to roll a steel ball by pushing it with a cue-like stick. After being told his mean score for five hits, he is asked to estimate his next trial score.

8:55 INSTRUMENTAL CONDITIONING is a psychophysiological test which utilizes the polygraph and requires the student to attempt to change the rate at which his heart beats. The object is to determine the extent to which this physiological function is under the student's voluntary control.

10:00 Coffe Break and urine sample taken

10:15 THE NEED FOR ACHIEVEMENT is measured by means of a technique involving the presentation of several situation pictures to the subject, requesting him to write a story about each and then scoring the stories in terms of the degree of need for achievement which is expressed.

10:35 CLASSICAL CONDITIONING is a psychophysiological test utilizing the polygraph in which the subject is presented with two tones which differ in pitch, one of which is paired with a mild pain stimulus to the big toe. The extent to which his autonomic response differs to the two tones was recorded.

12:10 Lunch

12:40 MINNESOTA COUNSELING INVENTORY is a test to identify three areas in which teenagers may be adjusting particularly well or poorly: family relationships, social relationships, and emotional stability; and to indicate four aspects of the student's characteristic ways of meeting problems: conformity, adjustment to reality, mood, and leadership.

1:40 EDWARDS PERSONALITY INVENTORY-This 1967 version is composed of 5 booklets of many hundreds of statements describing personality

and behavior which the subject marks a true or false as he believes other people who know him well would describe him. We used only booklet III consisting of 300 items from which 15 scales are scored ranging from "Motivated to Succeed" to "Neat in Dress."

2:40 LOCUS OF CONTROL is a brief inventory to determine to what extent the student's behavior is influenced by the expectation of the environment and by internalized values.

3:25 Interview

4:00 Leave Clinic (taken home in car)

Second Day:

8:00 Subject picked up by Clinic car and brought to Clinic

8:30 WECHSLER ADULT INTELLIGENCE SCALE is a standard individually administered test of I.Q. The full scale was given.

10:00 Coffe Break

10:15 THE SIXTEEN PERSONALITY FACTOR QUESTIONNAIRE is an inventory which measures such personality traits as enthusiasm, self discipline, and outgoing behavior tendencies.

10:45 OBJECT SORTING TEST is a measure of the ability to form concepts. It involves sorting objects common to everyday experience, such as forks and pliers into groups according to their objective characteristics.

11:15 Leave Clinic (taken home in car)

A urine sample was taken on the first day of testing and checked for the following drugs: Morphine, Methadone, Cocaine, Codiene, Quinine, amphetamines, and barbiturates. Six subjects were found to have one or more of these drugs in their urine and their data though collected, was not included. Neither the subjects nor any one else were told of the urine findings.

Before the paper and pencil tests were administered, the examiner examined the SCAT score, if available, or if not available, asked the subject to read the test directions aloud. If the score was too low or if he had difficulty reading, the examiner administered the tests orally.

b. Rationale for Test Battery

The rationale for selecting this particular set of tests and procedures was derived from (1) the primary goal of the study which was to identify sources of variance in school achievement beyond the I.Q. and (2) empirical evidence from previous studies which suggest these tests do measure some of the factors of achievement.

The Level of Aspiration Test has a long history of measuring motivation (K. Lewin, 1944) including my own little study in 1946 which developed the judgment error score and which successfully discriminated between the high and low motivation groups in our study (Ax and Bamford, 1968). In this study we chose the performance version rather than the paper and pencil version developed by Jensen and Rotter because we knew it would be of more intrinsic interest to this age group and likely to elicit their genuine motivation. The difference score (D) between estimate and previous accomplishment was scored as well as the judgment error score (JE) which is the absolute difference between estimate and score earned on that trial.

Operant conditioning consisted of 10 one minute trials with instructions to raise heart rate (HR), 10 one minute trials with instructions to lower HR with 20 one minute rest periods intersperced between the pseudo random interlaced Hi and Lo trials. A HR meter displayed the subject's HR to him on all the Hi and Lo trials whereas the meter was inoperative during the rest trials to prevent practice when rest was instructed. A white light lit just over a red sign of Hi or Lo on the right or left side of the meter to indicate to S the trial instruction and toward which side of the meter he should try to make the pointer go. The purpose of employing this operant learning task in addition to the classical conditioning was to utilize the additional motivation such a challenging task arouses and thus to help measure the current motivation as well as the aptitude for being motivated which I believe the classical conditioning best measures since for most people the learned behavior and often even the contingency is unconscious, thus preventing conscious current motivation from being operative.

The Wechsler Adult Intelligence Scale was administered to obtain the best estimate of intelligence essential for our definition of underachievement. The SCAT and STEP scores were not available for all subjects and from discussions with the school test administrators it was clear that these tests were taken by the students with widely varying motives and seriousness suggesting unreliability for the individual scores.

Originally the Minnesota Multiphasic Personality Inventory (MMPI) was to have been used to provide measures of personality disorder so that their contribution to underachievement could be determined. Since, however, the U.S. Office of Education ruled that this test may not be given to subjects in studies supported by OE funds we substituted another test -- the Minnesota Counseling Inventory (MCI) which omits the presumably offensive questions but still provides measures of personality disorder.

Classical conditioning of autonomic controlled variables constitutes the major experimental variable as on our two previous studies and the rationale that the rate and degree of new learning by this autonomic behavior constitutes a measure of the aptitude for learning motives and emotional control. The procedure was to attach sensors to the subject for recording (1) respiration, (2) heart rate, (3) finger plethysmogram, (4) frontalis muscle tension, (5) palmar skin conductance and (6) palmar skin potential.

The testing studio consisted of a sound attenuated room with one-way viewing ports and with the temperature controlled to 25.5° C + 0.2° C. The subject sat in a reclining chair and had audio communication with the experimenter. The beckman Type R dynograph, and the stimulus apparatus were in an adjoining room. Special couplers designed by our electronics staff were used for skin conductance and heart period. The standard Beckman couplers, including the high impedance electrometer Model 9808 for skin potential, were used for the other variables.

Skin conductance electrodes were O'Connell type, made of silver-silver chloride 3/8 inch in diameter, filled with Redux electrode paste, and attached on the volar surface of the distal phalanges of the third and fourth fingers of the left hand. Skin potential electrodes were the same type and located on the volar surface of the distal phalanx of the fifth finger of the left hand referenced to an electrode on the inner side of the left forearm about midway between wrist and elbow. Finger pulse was measured by an E & M photoelectric sensor located on the volar surface of the distal phalanx of the first finger. Respiration was measured by two Silastic tube mercury strain guages located on the chest and abdomen connected additively to a single bridge circuit. EKG electrodes were located on the right arm and left leg. The single ground electrode was located on the right ankle.

The skin conductance bridge provided a nearly constant 0.6 volt to the subject with a voltage output approximately linear with conductance of the subject. Current values ranged from 4.07 μamp/cm^2 for 5 μmho (200K) to 28.1 μamp/cm^2 for 50 μmho (20K) conductance values. The cardiotachometer produced an output voltage linear with heart period--beat by beat intervals (R wave to R wave) in milliseconds.

Stimuli given the subject consisted of tones and pain, the latter being produced by a D.C. electric current. The auditory stimuli, each of 12 seconds duration, were sine waves of 454 and 1276 Hz, interrupted 5 times per second, of approximately 50% duty cycle. Intensity was 70 db measured at the subject's ear with a General Radio sound level meter set on the C scale (ref. = 0.0002 dynes/cm^2). The pain stimulus consisted of a 4 sec duration, 3 ma continuous D.C. electric current applied to the pads of the great and adjacent toes of the right foot with 1 molar zinc sulphate wetted sponges backed by pure zinc plates in a plastic cup of 7 mm inside diameter. These characteristics produced a current density of 7.80 ma/cm^2. An electronic current-regulator maintained precisely this preset current regardless of skin or electrode resistance changes. This stimulus is perceived by most subjects as heat.

The "need for achievement test" developed by McClelland (in Atkinson, Ed., 1958) requires the subject to tell stories to 4 pictures: (two men working in a machine shop, a boy at his desk apparently pondering a paper he is writing, the father and son picture 7BM from TAT, and the boy and an operation scene in background 8BM from TAT.) The subject is instructed to look at the picture for 20 seconds and then write a phantasy with these 4 questions in mind (1) What is happening? (2) What has led up to the situation? (3) What is being thought--what is wanted by whom?

and (4) What will happen? Scoring followed McClelland's Manual (p. 179-204 in Atkinson, Ed., 1958). Research published by McClelland and others since 1954 indicate this phantasy test can measure the achievement motive with considerable validity.

Object sorting test was used as described by Rappaport, Gill and Shafer in Diagnostic Psychological Testing,1968. Part I consists of requiring S to sort or classify some 36 items from everyday life such as knives, forks, pliers, pipe, etc., into 7 successive categories with verbalization as to his rationale. There are 25 scores created by the examiner on both the conceptual span indicated by the adequacy and conceptual level judged from the verbal report. In Part II, E makes 12 successive groupings and S is asked to verbalize the theme which unites the group. The purpose of including this test was to see whether it could provide a still further contribution to the measurement of the conceptual factor in achievement possibly not fully explored by the WAIS.

The Sixteen Personality Factor Questionnaire Form E Copyright 1967, Institute for Personality and Ability Testing was developed by R. B. Catell and H. W. Eber. Both rationale and published research indicate the 16 PF has considerable validity for a comprehensive variety of personality factors. Specifically 3 of its scales G, L and M discriminated significantly between the high and low motivation groups in our 1968 study. In fact, the M factor which purports to measure "imaginativeness" and "creativity" had the third highest t-value of 3.38 in the 1968 study.

Locus of Control was developed by J. Rotter (1960) and the version used in this study, by James O. Miller,has two scores, the locus of control (internal or self vs. external or environment) and "evaluation" of his feelings in this regard. Research suggests that internal locus of control should correlate with motivation, ego strength and achievement. It seems plausible that the aptitude for learning emotional control and social motivation may underly the internal locus of control attitude.

Edwards Personality Inventory (EPI), Booklet Three was used in this study. The factors obtained from this inventory, according to Dr. Edwards are motivation to succeed, impressed by status, desires recognition, plans work efficiently, cooperative, competitive, articulate, feels superior, logical, assumes responsibility, self centered, makes friends easily, independent in his opinions, is a hard worker, neat in dress. Although there are other interesting factors especially in booklets 1A and 1B in addition to these 15, we felt that most of these additional ones would be picked up by the 16PF or the M.P.I.

There was also an interview done which sought to obtain information for the socioeconomic status, attitudes toward school and achievement in life, trends toward neuroticism or psychopathy. Our interviewer being Black and very experienced in working with delinquent and disturbed boys was quite skilled in building rapport with these students. The fact that all but one subject continued through the testing procedure by coming back the second day speaks well, I think, of his ability to motivate them.

c. Analysis Procedures

The data analysis began for the psychological data by hand scoring the various tests and tabulating the scores for computer card input. For the physiological data, the analysis began by our editing process. Editing was done by the experienced psychophysiology technicians who actually operated the polygraph during testing. There were two polygrams produced for each subject: One for classical and one for operant conditioning. Each contained the recording of six physiological variables, an event marker trace, a time code in seconds which was a precise count down from the 100 sample/second time code recorded on the magnetic tape which was used to time the computer during Analog-to-Digital (A/D) conversion during computer acquisition. After labeling the polygram time code in tens of seconds, the editor had available the precise time which could be estimated to the nearest tenth of a second.

The first editing job was to identify and list the times of onset and offset of each epoch for analysis. For the operant conditioning session there were 10 high, 10 low and 21 rest periods pseudo randomly interlaced totalling 41 epochs for analysis. For the classical conditioning there were 127 scoring epochs consisting of 21 high pitched tones of 10 seconds duration, 20 low pitched tones of 10 seconds duration, 21 pain stimuli of 4 seconds duration, 20 no pain intervals of 4 seconds, 41 intertrial intervals of from 45 to 60 seconds, two rest periods of 3 minutes and two BP epochs of 3 minutes during which BP was taken by hand before and after conditioning. These epoch points served to mark the periods for including analysis and for specific points to obtain a data point value.

The editor also coded the gain and offset values written on the polygram by the recording technician to be used by the computer in its conversion programs described below. Since during the changes in gain and offset, invalid recording was made the editor edited out the portion of the record that was invalid. The recording operators were trained to make these changes in gain and offset as quickly as possible. They were made all through the records when the subjects' physiological values changed beyond the rather narrow limits of the pen. The pen and mag tape channel limits were made equal and rather high gains were used so that optimum resolution would be possible. The A/D conversion used 14 bits and hence had a maximum resolution of 16384 which was more than adequate for our data. The Ampex Mag Tape Recorder used the + 1.8 RMS with a resolution of about 6 or 7 millivolts which provides about 1 part in 500 or about 0.2%. Of course this is about 10 times the resolution that can be read on a polygram. Thus we believe there was little or no loss of information from the raw data in these computer processes.

Editing for the elimination of artifact or bad data due to any cause was based on the experienced judgment of the editor as to what constitutes valid data. Any error of inclusion of invalid data or exclusion of valid data could only degrade the data in a random way with regard to the hypotheses under study since the editor had no way of knowing how a particular portion of the data could affect such hypotheses. There were two types of edits. A short edit bridged across a short section of good data by means of a cubic equation which utilized two samples just before the edit and 2 samples just after the edit, thus making it possible to fill

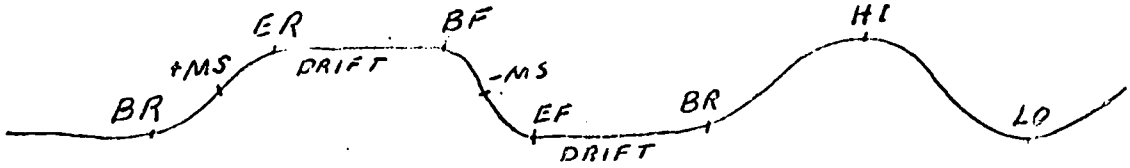
in short curved portions even including a high or low. If the portion of invalid data to be edited out was too long or if the editor judged the "true" data curve would too complex for the extrapolation formula to accurately fill in, he used the long edit which directed the computer to stop analysis and skip to the point of End Edit (EE). Careful comparison sampling of the computer's performance in this editing with hand filled in short edits established the general validity of the process. Both the raw polygrams and computer prepared analog curves made from the digital values. When all this editing information had been key punched the cards were utilized along with the data from the mag tape by the computer for the analysis. The next step was to do the A/D conversion, called acquisition, of the data from the analog mag tape record via a computer terminal in our lab. The IBM 1800 Computer up one floor acquired the data by being timed by the 100 S/S time pulses on the analog tape. Actually the analog tape was reproduced at 15"/sec which was 8 times the original acquisition rate of 1 7/8/sec. Thus the actual A/D rate was 800 S/S per variable. It sampled the six variables once each in the 1/800 second between timing pulses. These samples were recorded on a continuous interspersed form on the first digital acquisition tape. The second tape called the TST tape blocked the data into 100 samples per variable and supplied appropriate headers so that future programs could find the desired data. The third step filtered the data, smoothing out noise by a weighted digital smoothing system which most efficiently preserved the data. The smoothing was tailored for each variable so as to best remove the small or brief noise that was too small to edit out. Again computer prepared graphs were used to adjust the smoothing to an optimum value. The great advantage of digital over analog filtering is the lack of lag introduced since digital smoothing "looks ahead" as well as back, and because it can be adjusted and redone as often as desired without destruction of the raw data. After smoothing the computer compressed the data into 10 samples per second per variable from the original 100 S/S thus reducing the amount of data to 1% of its original amount. Since the fastest changing variables (respiration, HR and MT) could not complete a cycle of change in less than one second, after filtering, we judged the 10 S/S would faithfully mediate the data for digital statistical analysis. The fourth step in the computer was to scale and convert each variable to physiological units. Mathematical formulae were prepared for this purpose for each variable based on the electronic calibration of the transducers and amplifiers. After application of the formula to each variable, the digital values were checked and if any discrepancy was found throughout the range of the variable, the formula was corrected, if necessary, by use of non-linear transformations.

The final physiological units were for respiration, inches stretch of the mercury filled silastic strain gages around the chest and abdomen. Heart rate was in beats/min but each single R-R interval was measured. Finger plethysmogram was in millivolts of the transducer output since we had no more basic calibration such as volume changes. Muscle tension was in microvolts at the transducer. The "leaky-peak" detector integrator output was calibrated by a 400 Hz microvolt source. Zero values were set with the electrodes in place on the subject but shorted so as to have a

zero MT level to start from and which would include any common mode noise not excluded by the preamplifier. Skin potential was recorded in millivolts using the very high impedence (>100 megohms) Beckman type 9808 electrometer coupler. Skin conductance was recorded in micromho units of conductance.

The next computing step was to find and measure the "points of interest" (PI). See Table 1. This concept and program development has had a long history. The concept to devise a general method to find all the points of interest in any continuous physiological recording was conceived by Ax about 1952 while working on the Fear and Anger study at Harvard. Several abortive attempts to use analog computing were abandoned and the digital approach was began in 1957. The first success was achieved with the help of Sam Singer, M.D. and George Zachary using the Bender G-15 drum type computer resulting in a publication by Ax, Singer, Zachary, Gubobba and Gottlieb in 1964. Later the program was rewritten by Singer and R. Stahlky for the IBM 7094. This version is reported in my Chapter 14 of Venables and Martin (Eds) 1967. Next the programs were rewritten for the IBM 1800 by the following programmers: John Gorham, William Fetzner, J. Porzak, J. Grisell, D. Geller, Benay Abrams, and G. Langolf, all under the general supervision of Ax. A NASA grant (Ax, 1968) supported much of this programming work. John Gorham, Dr. Grisell and Ax carried out the final debugging and revisions so as to make them all work satisfactorily. The effort to accomplish this turned out to exceed the expectations of all of us.

The PI program compares adjacent groups of samples so as to identify the following 8 PI. See figure below:



In addition all edit and epoch points are found from the editor's input. For all PI the type, time, and amplitude are computed and saved. For the maximum slope points the slope is also determined. (See appendix for sample of PI output) The premise underlying the PI procedure is that there are physiological responses that can be identified by their more rapid rates of change than the gradual homeostatic drifts which change more slowly. The difference in rate of change between a response and a homeostatic drift is, of course, a matter of degree but it seems the concept has sufficient merit to be useful for the psychophysiologist. This study is the first one in which we have had the opportunity to give the concept and method a large scale test.

In order to select the rates of change desired, two tolerances are set. (1) Amplitude Tolerance (AT) and (2) Time Tolerance (TT). The AT together with the time over which the samples of data are compared (since 2 or more samples may be used to provide additional smoothing) determines the minimum slope required to reach response status. All slopes less than response are called drifts. The TT defines how long a slope of less than response status must prevail to achieve the no-response or drift status. Since both ends of a drift are recorded as the end and beginning of the adjacent responses, and we know the variable could not have exceeded the

TABLE 1

POINTS OF INTEREST OUTPUT SAMPLE

IDENTIFICATION OF PI FILES OF CURRENT INT

FILE PROTECT CODE...	NO	STUDY....
ACCESSION.....	124	SESSION..
ANALOG TAPE.....	22	SUBJECT..
TIMES DIGITIZED.....	1	PI RUN...
SMOOTHED TAPE.....	0	PI TAPE..

NO.	VAR TITLE	ATOL	TTOLR
1	RESPIRATION	0.06000	0.4
2	CARDIOTACHOMETER	0.60000	0.2
4	FINGER PULSE DC	0.00070	1.4
5	MUSCLE TENSION	4.00000	1.0
6	SKIN CONDUCTANCE	0.25000	0.8
7	SKIN POTENTIAL	0.31000	0.8
10	TIME CODE (1.0/SEC)	0.50000	0.2

***IDENTIFICATION SUMMARY COMPLETE

	1
	1
	49
	1
	1

TTOLD	NO. PI
1.5	2618
2.0	2541
3.0	447
1.5	513
3.0	128
3.0	147
0.2	9

VARIABLE NO. 1 NO.P

TIME	TYPE	AMPLITUDE SUM,SMSO,SLOPE		TIME	TYPE
26.8	EP1	2.2099	0.000E 00	74.9	LO
27.2	FS	1.8199	-0.107E 01	76.0	RS
29.2	LO	1.0898	-0.109E 00	76.2	HI
30.0	RS	1.6897	0.134E 01	76.5	FS
30.6	HI	2.2478	0.546E 00	77.9	LO
31.3	FS	1.8177	-0.856E 00	79.4	RS
33.5	LO	1.1579	-0.878E-01	79.6	HI
34.3	RS	2.0435	0.153E 01	79.7	FS
34.7	HI	2.4538	0.862E 00	79.8	LO
35.5	FS	1.8776	-0.111E 01	80.0	RS
37.5	LO	1.1338	-0.357E-01	80.1	HI
38.3	RS	1.9957	0.142E 01	80.3	FS
38.7	HI	2.3516	0.749E 00	85.4	EF
40.6	FS	1.5496	-0.900E 00	86.8	EP1
41.3	LO	1.1816	-0.428E 00	86.8	EP2
42.1	RS	1.8078	0.126E 01	87.5	BR
42.7	HI	2.3736	0.683E 00	88.3	RS
43.6	FS	1.8496	-0.884E 00	88.5	HI
45.6	LO	1.1277	-0.140E 00	88.7	FS
46.5	RS	2.1138	0.166E 01	89.3	LO
46.9	HI	2.5137	0.900E 00	89.6	RS
47.8	FS	1.8759	-0.859E 00	89.9	HI
49.6	LO	1.0898	-0.247E-01	90.1	FS
50.5	RS	1.9435	0.135E 01	90.6	LO
50.9	HI	2.3599	0.101E 01	91.1	RS
51.9	FS	1.6815	-0.911E 00	91.3	HI
53.0	LO	1.1717	-0.365E 00	91.6	FS
53.8	RS	1.9155	0.134E 01	92.0	LO
54.2	HI	2.3055	0.889E 00	92.3	RS
55.0	FS	1.7699	-0.100E 01	92.7	HI
56.2	LO	1.1519	-0.335E 00	93.0	FS
56.9	RS	1.8479	0.128E 01	93.5	LO
57.5	HI	2.2857	0.469E 00	93.8	RS
58.1	FS	1.7858	-0.104E 01	94.1	HI
59.4	LO	1.1958	-0.153E 00	94.4	FS
59.9	RS	1.5815	0.117E 01	95.1	LO
60.7	HI	2.2237	0.815E 00	95.5	RS
61.3	FS	1.8897	-0.969E 00	95.8	HI
63.0	LO	1.1058	-0.129E 00	96.0	FS
63.9	RS	1.9358	0.136E 01	96.6	LO
64.3	HI	2.2918	0.736E 00	97.0	RS
65.1	FS	1.7957	-0.925E 00	97.2	HI
66.8	LO	1.1239	-0.247E-01	97.5	FS
67.6	RS	1.8655	0.139E 01	98.2	LO
68.1	HI	2.3599	0.791E 00	98.8	RS
69.0	FS	1.8056	-0.876E 00	99.0	HI
70.5	LO	1.1656	-0.170E 00	99.3	FS
71.7	RS	1.9039	0.129E 01	100.1	LO
72.2	HI	2.3198	0.601E 00	100.4	RS
72.9	FS	1.9418	-0.845E 00	100.9	HI

T 1 Continued

FOUND WAS 2618 NO.PI STORED WAS 2618

AMPLITUDE	SUM,SMSO,SLOPE	TIME	TYPE	AMPLITUDE	SUM,SMSO,SLOPE
1.1854	-0.225E 00	101.2	FS	3.4816	-0.332E 01
3.0317	0.289E 01	101.9	LO	2.0578	-0.131E 01
3.4959	0.266E 01	102.4	RS	3.3196	0.358E 01
2.7757	-0.272E 01	102.7	HI	4.2155	0.306E 01
1.6578	-0.255E 00	103.1	FS	3.3295	-0.327E 01
5.0456	0.479E 01	103.7	LO	2.0874	-0.153E 01
5.6438	0.405E 01	104.2	RS	3.1718	0.307E 01
5.1478	-0.336E 01	104.6	HI	4.0337	0.189E 01
4.6935	-0.336E 01	104.9	FS	3.1537	-0.313E 01
6.5156	0.803E 01	105.5	LO	2.0858	-0.105E 01
6.7474	0.803E 01	105.9	RS	2.9779	0.329E 01
6.1355	-0.288E 01	106.4	HI	4.0139	0.154E 01
2.4247	0.000E 00	106.7	FS	3.1355	-0.321E 01
2.3758	0.193E 01	107.2	LO	2.1759	-0.145E 01
0.0109	0.739E 00	107.6	RS	3.0757	0.313E 01
2.2692	-0.134E 00	107.9	HI	3.7975	0.245E 01
4.3177	0.546E 01	108.2	FS	3.0954	-0.286E 01
5.0555	0.466E 01	108.8	LO	1.9979	-0.128E 01
3.8898	-0.599E 01	109.3	RS	2.8779	0.274E 01
1.8095	-0.249E 01	109.9	HI	4.2897	0.274E 01
3.8359	0.791E 01	110.4	FS	3.3937	-0.243E 01
5.4999	0.791E 01	111.2	LO	1.9836	-0.136E 01
4.1057	-0.675E 01	112.0	RS	3.7134	0.270E 01
2.0517	-0.345E 01	112.4	HI	4.4259	0.158E 01
4.5237	0.697E 01	112.8	FS	3.3196	-0.337E 01
5.5499	0.604E 01	113.5	LO	2.0918	-0.100E 01
3.8217	-0.677E 01	114.1	RS	3.2679	0.328E 01
2.0237	-0.413E 01	114.5	HI	4.4078	0.286E 01
3.9019	0.819E 01	114.9	FS	3.4157	-0.326E 01
5.9437	0.458E 01	115.9	LO	1.9276	-0.422E 00
4.3056	-0.580E 01	116.6	RS	3.5519	0.322E 01
2.2418	-0.325E 01	116.9	HI	4.1996	0.221E 01
3.6799	0.530E 01	117.2	FS	3.3816	-0.373E 01
4.3715	0.240E 01	117.9	LO	2.1715	-0.785E 00
3.5355	-0.329E 01	118.5	RS	3.1158	0.298E 01
2.0275	-0.119E 01	118.8	HI	3.8195	0.246E 01
3.2839	0.470E 01	119.1	FS	2.9938	-0.313E 01
4.1199	0.293E 01	119.9	LO	2.0874	-0.313E 01
3.3157	-0.393E 01	120.5	RS	3.4256	0.341E 01
2.1478	-0.140E 01	120.9	HI	4.3435	0.196E 01
3.6695	0.473E 01	121.3	FS	3.4239	-0.302E 01
4.3919	0.411E 01	122.2	LO	2.0654	-0.395E 00
3.5179	-0.411E 01	122.6	RS	3.1658	0.352E 01
2.1819	-0.102E 01	123.0	HI	4.2139	0.253E 01
3.8475	0.340E 01	123.3	FS	3.1674	-0.379E 01
4.4056	0.311E 01	124.1	LO	2.0874	-0.417E 00
3.6678	-0.354E 01	124.6	RS	3.4855	0.408E 01
2.0737	-0.994E 00	124.9	HI	4.2496	0.275E 01
2.8999	0.342E 01	125.1	FS	3.4558	-0.407E 01
4.3375	0.269E 01	125.9	LO	2.1539	-0.494E 00

VARIABLE NO. 2 NO.PI FOUND WAS 2541 NU

TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE	TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE
26.8	EP1	58.6199	0.000E 00	73.2	HI	66.5547	0.000E 00
27.1	RS	65.8223	0.256E 02	74.6	FS	62.4347	-0.162E 02
27.3	HI	66.3899	0.610E 00	76.2	LO	59.8040	0.000E 00
28.0	FS	61.5375	-0.266E 02	76.5	RS	68.9230	0.411E 02
29.9	LO	54.3829	-0.266E 02	77.1	HI	73.1894	0.427E 00
31.2	RS	65.1631	0.219E 02	78.3	FS	63.8081	-0.216E 02
31.8	HI	65.6270	0.183E 00	78.9	LO	59.4195	-0.305E 00
33.2	FS	55.9282	-0.227E 02	79.2	RS	74.8802	0.664E 02
34.1	LO	51.5762	-0.122E 00	80.3	HI	84.2982	0.305E 00
35.4	RS	64.9311	0.335E 02	81.8	FS	64.8457	-0.113E 03
35.9	HI	65.5903	0.000E 00	82.5	LO	47.4257	-0.366E 00
36.2	FS	63.4540	-0.170E 02	82.9	RS	67.0369	0.686E 02
38.2	LO	54.8783	-0.244E 00	83.4	HI	68.2943	0.000E 00
39.4	RS	63.4723	0.272E 02	83.8	FS	62.1723	-0.394E 02
39.9	HI	65.8955	0.272E 02	84.1	EF	55.7451	0.000E 00
40.3	FS	63.1550	-0.173E 02	86.8	EP1	56.1906	0.603E 02
42.2	LO	54.9699	-0.244E 00	86.8	EP2	0.0000	0.391E 02
43.5	RS	62.3004	0.219E 02	88.7	BR	57.5640	-0.122E 00
43.8	HI	64.0827	0.366E 00	89.0	RS	68.9230	0.496E 02
44.5	FS	59.7552	-0.335E 02	89.4	HI	73.4580	0.244E 00
46.4	LO	52.8353	0.000E 00	89.8	FS	71.5964	-0.885E 01
47.7	RS	68.6300	0.275E 02	90.3	LO	70.3390	0.000E 00
48.1	HI	69.2587	0.000E 00	90.6	RS	77.1935	0.296E 02
48.6	FS	63.0573	-0.283E 02	90.9	HI	80.0500	0.549E 00
50.4	LO	55.6657	0.000E 00	91.4	FS	76.7479	-0.126E 02
51.7	RS	63.3381	0.236E 02	91.8	LO	75.5882	0.000E 00
52.1	HI	65.2668	0.000E 00	92.2	RS	79.5739	0.145E 02
52.7	FS	59.9078	-0.308E 02	92.4	HI	80.1599	0.305E 00
53.6	LO	55.1469	0.000E 00	95.5	FS	65.7490	-0.452E 02
54.8	RS	61.6473	0.249E 02	96.1	LO	59.2425	-0.427E 00
55.1	HI	64.0156	0.183E 00	96.4	RS	68.2149	0.408E 02
55.8	FS	59.7003	-0.234E 02	96.9	HI	72.5058	0.427E 00
57.6	LO	54.4084	-0.122E 00	97.3	FS	67.2811	-0.250E 02
58.0	RS	61.8854	0.266E 02	97.9	LO	64.0156	0.000E 00
58.6	HI	62.6300	0.000E 00	98.3	RS	68.2760	0.137E 02
60.0	FS	56.7888	-0.140E 02	98.5	HI	68.5262	0.000E 00
60.7	LO	54.8783	-0.244E 00	99.1	FS	67.0369	-0.701E 01
61.1	RS	59.5477	0.166E 02	99.7	LO	66.1336	-0.366E 00
62.2	HI	61.3177	0.671E 00	100.0	RS	68.9046	0.116E 02
63.0	FS	59.5233	-0.909E 01	100.3	HI	69.8873	0.244E 00
63.8	LO	57.9973	-0.122E 00	100.8	FS	68.3553	-0.964E 01
65.0	RS	67.0186	0.253E 02	101.4	LO	66.5181	-0.183E 00
65.2	HI	68.0623	0.793E 00	101.8	RS	72.3288	0.195E 02
65.9	FS	63.2892	-0.231E 02	102.0	HI	72.8110	0.427E 00
67.6	LO	52.9495	0.000E 00	102.6	FS	69.3197	-0.153E 02
68.8	RS	66.4265	0.156E 02	103.1	LO	67.6778	-0.366E 00
69.2	HI	68.0990	0.000E 00	103.5	RS	73.7266	0.204E 02
70.8	FS	58.8946	-0.167E 02	104.0	HI	74.1599	0.183E 00
71.3	LO	56.8315	-0.244E 00	104.2	FS	72.0053	-0.142E 02
72.8	RS	65.7490	0.214E 02	104.8	LO	69.2831	-0.366E 00

PI STORED WAS 2541

TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE
105.1	RS	72.9880	0.160E 02
105.5	HI	74.6482	0.000E 00
105.9	FS	71.6147	-0.189E 02
106.5	LO	68.2577	0.000E 00
106.8	RS	71.8771	0.164E 02
107.1	HI	73.6411	0.000E 00
107.7	FS	70.4184	-0.117E 02
108.2	LO	69.6432	-0.183E 00
108.5	RS	73.9097	0.169E 02
109.0	HI	75.0206	0.244E 00
109.3	FS	71.6391	-0.168E 02
109.8	LO	69.2831	-0.366E 00
110.2	RS	73.2810	0.147E 02
110.5	HI	74.1416	0.244E 00
111.8	FS	70.0705	-0.178E 02
112.3	LO	67.0369	-0.549E 00
112.7	RS	72.5913	0.235E 02
113.1	HI	74.7642	0.000E 00
113.5	FS	71.4072	-0.195E 02
115.0	LO	66.5364	-0.183E 00
115.3	RS	72.3715	0.246E 02
115.6	HI	74.5750	0.183E 00
116.1	FS	70.9189	-0.233E 02
116.7	LO	66.6097	-0.366E 00
117.1	RS	70.1132	0.128E 02
117.6	HI	70.6076	0.000E 00
118.8	FS	65.8223	-0.128E 02
119.1	EF	65.6555	0.000E 00
121.3	BR	64.2536	0.183E 00
121.6	RS	72.8354	0.339E 02
122.1	HI	74.7154	0.244E 00
122.5	FS	67.3177	-0.565E 02
123.2	LO	57.0024	-0.122E 00
123.5	RS	64.8823	0.355E 02
124.2	HI	68.5079	0.183E 00
124.5	FS	61.8182	-0.379E 02
125.1	LO	56.2028	-0.122E 00
125.5	RS	67.8487	0.441E 02
125.7	HI	69.3990	0.115E 01
126.4	FS	63.7592	-0.411E 02
127.1	LO	56.2395	-0.183E 00
127.4	RS	63.3564	0.330E 02
127.7	HI	67.1285	0.366E 00
128.4	FS	61.7084	-0.379E 02
129.1	LO	54.9516	0.000E 00
129.5	RS	61.5192	0.256E 02
129.7	HI	62.9902	0.976E 00
130.5	FS	58.4063	-0.242E 02
131.3	LO	54.8295	-0.244E 00
132.6	RS	63.6433	0.162E 02

minimal rate of change, there is little mystery about the variable's behavior. The PI program produces too much output in a major study such as this one to conveniently handle or inspect. Samples of the PI from near the beginning and end of each subject's record were printed out and inspected to make sure that all had gone well up to this point.

The summary computer program (See Tables 2 and 3) selected parameters from these P.I. The parameters we selected for this study were not exhaustive due to programming and computing limitations and are tailored to each variable and to the experimental procedure and goals of this study. Other summary programs could be prepared for other variables and/or other studies from the data provided by the same P.I. program.

Certain variables have similar response characteristics as to types of responses and will be grouped together for economy of exposition. An important consolidation of the data was achieved by computing the mean value of each parameter over a uniform type of epoch. For example, in the session of operant conditioning of HR the high trials were combined into a single mean of each parameter.

For classical conditioning for all variables there were 8 epochs: Rest 1, (3 minutes) orienting response to the first tone, orienting response to the first pain stimulus, the 20 high pitched tones followed by the pain stimulus, (UCS), the 20 pain stimuli, low pitched tone, the no pain period following the low tone, and rest 2 (3 minutes). For operant conditioning there were only 3 epochs for all variables. Rest, Hi and Lo, there being 10 one-minute trials each of Hi and Lo with 21 one-minute rest periods interspersed between them. Samples of summary output are in the appendix.

Respiration was unique for our summary program. The parameters for inspiration and expiration scored separately were duration, time constant, magnitude, maximum slope and the ratio of duration of inspiration/duration of that respiration cycle and the numbers of each.

Muscle tension, skin conductance and finger plethysmogram were uniphasic response variables which could be summarized in the same manner. The parameters for increments and decrements separately were duration, time constant, magnitude, slope and latency and the number of each per epoch.

Heart rate and skin potential being multiphasic response variables have for all the epochs other than rest, increments and decrements as first and also as second responses summarized separately. We thought this analysis of first and second responses for diphasic variables should be done since the physiological and psychological significance of HR increments has been shown to be different from HR decrements (Graham, F. and Jackson, J. D., 1972; Lacey, J. I., 1967.) and it seems likely that the order in which they occur to a stimulus might carry additional significance. There are disadvantages however, of such a detailed analysis because the number of parameters is doubled for these diphasic variables and the number of responses to each type may be greatly reduced since neither HR nor SP always has diphasic responses.

VARIABLE - RESPIRATION

TABLE 2

SUMMARY OUTPUT FOR CLASSICAL CONDITI

REST 1	DUR	NO.	TC	NO.	MAG
INC	1.38	52.00	0.51	53.00	1.47
DEC	2.01	53.00	0.61	53.00	-1.49
	MEAN =	0.78	SDV =	0.52	NO. =
OR TONE	DUR	NO.	TC	NO.	MAG
INC	1.39	1.00	0.54	2.00	1.30
DEC	1.50	2.00	0.54	2.00	-1.28
	MEAN =	0.72	SDV =	0.42	NO. =
OR PAIN	DUR	NO.	TC	NO.	MAG
INC	0.89	3.00	0.35	4.00	1.09
DEC	1.03	3.00	0.33	3.00	-0.93
	MEAN =	0.98	SDV =	0.42	NO. =
HI TONE	DUR	NO.	TC	NO.	MAG
INC	1.33	26.00	0.44	30.00	1.13
DEC	1.77	22.00	0.62	29.00	-1.13
	MEAN =	0.22	SDV =	0.69	NO. =
PAIN	DUR	NO.	TC	NO.	MAG
INC	1.32	37.00	0.42	43.00	1.13
DEC	1.84	36.00	0.59	36.00	-1.11
	MEAN =	0.30	SDV =	0.66	NO. =

NO.	SLOPE	NO.	DI/DC
53.00	1.62	53.00	0.406
53.00	-1.35	53.00	
1800.00			
NO.	SLOPE	NO.	DI/DC
2.00	1.37	2.00	0.482
2.00	-1.36	2.00	
57.99			
NO.	SLOPE	NO.	DI/DC
4.00	1.80	4.00	0.465
3.00	-1.18	3.00	
40.00			
NO.	SLOPE	NO.	DI/DC
30.00	1.37	35.00	0.428
27.00	-1.32	34.00	
1170.01			
NO.	SLOPE	NO.	DI/DC
43.00	1.34	43.00	0.417
38.00	-1.27	38.00	
778.99			

VARIABLE = RESPIRATION

LO TOUCH	DUR	NO.	TC	NO.
INC	1.29	31.00	0.34	37.
DEC	1.58	24.00	0.52	35.
	MEAN =	0.37	SDV =	

NO PAIN	DUR	NO.	TC	NO.
INC	1.26	37.00	0.42	41.
DEC	1.39	32.00	0.40	32.
	MEAN =	0.12	SDV =	

REST 2	DUR	NO.	TC	NO.
INC	1.79	48.00	0.34	48.
DEC	1.92	48.00	0.56	48.
	MEAN =	-0.45	SDV =	

TABLE 2 Continued

	MAG	NO.	SLOPE	NO.	DI/DC
00	1.33	37.00	1.70	39.00	0.448
00	-1.19	26.00	-1.71	37.00	
1.03	NO. =	1158.99			
	MAG	NO.	SLOPE	NO.	DI/DC
00	1.12	41.00	1.45	41.00	0.400
00	-1.00	35.00	-1.25	35.00	
0.66	NO. =	785.00			
	MAG	NO.	SLOPE	NO.	DI/DC
00	0.90	48.00	1.41	48.00	0.402
00	-0.90	48.00	-1.08	48.00	
0.57	NO. =	1800.00			

VARIABLE - HEART RATE

TABLE 2 Continued

REST 1	DUR	NO.	TC	NO.	MAG
INC	0.95	48.00	0.39	48.00	4.34
DEC	2.07	39.00	0.78	40.00	-4.86

MEAN = 60.13 SDV = 2.76 NO. =

INCREMENT AS FIRST RESPONSE

OR TONE	DUR	NO.	TC	NO.	MAG
INC	0.50	1.00	0.19	1.00	2.89
DEC	2.50	1.00	1.80	1.00	-3.72

DECREMENT AS FIRST RESPONSE

OR TONE	DUR	NO.	TC	NO.	MAG
DEC	0.00	0.00	0.00	0.00	0.00
INC	0.00	0.00	0.00	0.00	0.00

MEAN = 58.74 SDV = 1.18 NO. =

INCREMENT AS FIRST RESPONSE

OR PAIN	DUR	NO.	TC	NO.	MAG
INC	0.60	1.00	0.40	1.00	3.91
DEC	0.79	1.00	0.59	1.00	-2.64

DECREMENT AS FIRST RESPONSE

OR PAIN	DUR	NO.	TC	NO.	MAG
DEC	0.00	0.00	0.00	0.00	0.00
INC	0.00	0.00	0.00	0.00	0.00

MEAN = 59.13 SDV = 1.47 NO. =

NO.	SLOPE	NO.	LAT	NO.
48.00	12.00	48.00		
39.00	-11.02	40.00		
800.00				

NO.	SLOPE	NO.	LAT	NO.
1.00	8.97	1.00	0.89	1.00
1.00	-7.08	1.00		

NO.	SLOPE	NO.	LAT	NO.
0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00		
57.99				

NO.	SLOPE	NO.	LAT	NO.
1.00	13.30	1.00	1.29	1.00
1.00	-7.56	1.00		

NO.	SLOPE	NO.	LAT	NO.
0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00		
40.00				

VARIABLE - HEART RATE

INCREMENT AS FIRST RESPONSE

HI TONE	DUR	NO.	TC	NO.
INC	1.62	8.00	0.46	12.
DEC	1.52	7.00	0.79	10.

DECREMENT AS FIRST RESPONSE

HI TONE	DUR	NO.	TC	NO.
DEC	1.45	4.00	0.92	8.
INC	1.03	8.00	0.77	8.

MEAN = 61.95 SDV =

INCREMENT AS FIRST RESPONSE

PAIN	DUR	NO.	TC	NO.
INC	0.61	10.00	0.29	11.
DEC	2.04	8.00	0.59	8.

DECREMENT AS FIRST RESPONSE

PAIN	DUR	NO.	TC	NO.
DEC	1.70	3.00	0.92	8.
INC	1.14	7.00	0.75	7.

MEAN = 60.27 SDV =

INCREMENT AS FIRST RESPONSE

LO TONE	DUR	NO.	TC	NO.
INC	0.58	8.00	0.29	12.
DEC	1.63	6.00	0.61	7.

DECREMENT AS FIRST RESPONSE

LO TONE	DUR	NO.	TC	NO.
DEC	1.19	4.00	0.92	7.
INC	0.84	4.00	0.90	6.

MEAN = 61.47 SDV =

LE ntinued

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	8.72	12.00	15.49	12.00	1.57	8.00
00	-4.93	7.00	-17.32	10.00		

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	-4.02	8.00	-10.66	8.00	0.64	4.00
00	5.47	8.00	14.00	8.00		
4.59	NO. =	1170.01				

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	3.54	11.00	11.46	11.00	1.33	10.00
00	-5.40	8.00	-14.03	8.00		

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	-6.43	8.00	-18.73	8.00	1.40	3.00
00	4.00	7.00	10.82	7.00		
3.47	NO. =	778.99				

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	5.74	13.00	15.27	13.00	1.63	9.00
00	-4.96	6.00	-12.76	7.00		

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	-4.49	7.00	-14.19	7.00	0.32	4.00
00	3.85	4.00	14.36	6.00		
5.08	NO. =	1158.99				

VARIABLE - HEART RATE

TABLE 2 Continued

INCREMENT AS FIRST RESPONSE

NO PAIN	DUR	NO.	TC	NO.	MAG
INC	0.54	4.00	0.27	7.00	3.16
DEC	1.68	5.00	0.57	5.00	-6.36

DECREMENT AS FIRST RESPONSE

NO PAIN	DUR	NO.	TC	NO.	MAG
DEC	1.78	6.00	1.19	12.00	-6.14
INC	0.75	12.00	0.48	12.00	3.53
	MEAN =	61.82	SDV =	4.02	NO. =

REST 2	DUR	NO.	TC	NO.	MAG
INC	0.96	34.00	0.47	34.00	3.19
DEC	1.76	24.00	0.83	24.00	-6.22
	MEAN =	58.98	SDV =	4.36	NO. =

NO.	SLOPE	NO.	LAT	NO.
7.00	10.82	7.00	1.15	4.00
5.00	-12.62	5.00		

NO.	SLOPE	NO.	LAT	NO.
12.00	-15.15	12.00	0.44	6.00
12.00	10.60	12.00		

785.00

NO.	SLOPE	NO.	LAT	NO.
34.00	12.39	34.00		
24.00	-14.47	24.00		

1800.00

VARIABLE - GSR

REST 1	DUR	NO.	TC	NO.
INC	1.00	1.00	0.50	1.
DEC	0.00	0.00	0.00	0.
	MEAN =	7.22	SDV =	
OR TONE	DUR	NO.	TC	NO.
INC	2.00	1.00	1.09	1.
DEC	0.00	0.00	0.00	0.
	MEAN =	7.44	SDV =	
OR PAIN	DUR	NO.	TC	NO.
INC	11.00	1.00	10.20	1.
DEC	6.20	1.00	3.39	1.
	MEAN =	8.76	SDV =	
HI TONE	DUR	NO.	TC	NO.
INC	2.06	8.00	1.18	8.
DEC	0.00	0.00	1.29	1.
	MEAN =	10.27	SDV =	
PAIN	DUR	NO.	TC	NO.
INC	3.26	9.00	2.04	11.
DEC	3.62	17.00	1.89	17.
	MEAN =	12.40	SDV =	

2 Continued

	MAG	NO.	SLOPE	NO.	LAT	NO.
00	0.41	1.00	0.65	1.00		
00	0.00	0.00	0.00	0.00		
0.32	NO. =	1800.00				
	MAG	NO.	SLOPE	NO.	LAT	NO.
00	1.33	1.00	1.02	1.00	2.79	1.00
00	0.00	0.00	0.00	0.00	0.00	0.00
0.70	NO. =	57.99				
	MAG	NO.	SLOPE	NO.	LAT	NO.
00	8.53	1.00	1.95	1.00	2.40	1.00
00	-2.96	1.00	-0.76	1.00	0.00	0.00
0.55	NO. =	40.00				
	MAG	NO.	SLOPE	NO.	LAT	NO.
00	2.64	20.00	1.79	18.00	2.17	20.00
00	0.00	0.00	-0.82	1.00	0.00	0.00
1.87	NO. =	1170.01				
	MAG	NO.	SLOPE	NO.	LAT	NO.
00	2.76	20.00	1.61	11.00	2.05	9.00
00	-2.19	17.00	-0.90	17.00	6.36	9.00
1.60	NO. =	778.99				

VARIABLE - GSR

TABLE 2 Concluded

LO TONE	DUR	NO.	TC	NO.	MAG
INC	2.06	17.00	1.18	17.00	1.68
DEC	0.00	0.00	0.00	0.00	0.00
	MEAN =	9.85	SDV =	1.58	NO. =
NO PAIN	DUR	NO.	TC	NO.	MAG
INC	2.75	4.00	1.85	4.00	2.70
DEC	2.90	2.00	1.95	2.00	-1.46
	MEAN =	10.47	SDV =	1.42	NO. =
REST 2	DUR	NO.	TC	NO.	MAG
INC	2.03	6.00	0.81	6.00	1.20
DEC	0.79	1.00	0.19	1.00	-1.33
	MEAN =	9.22	SDV =	0.91	NO. =

NO.	SLOPE	NO.	LAT	NO.
20.00	1.44	20.00	2.29	19.00
0.00	0.00	0.00	0.00	0.00
158.99				
NO.	SLOPE	NO.	LAT	NO.
5.00	2.01	4.00	6.17	4.00
2.00	-0.84	2.00	0.00	0.00
785.00				
NO.	SLOPE	NO.	LAT	NO.
6.00	1.09	6.00		
1.00	-1.42	1.00		
1800.00				

SUMMARY OUTPUT FO

VARIABLE - RESPIRATION

REST	DUR	NO.	TC	NO.
INC	1.66	316.00	0.49	323.0
DEC	1.63	324.00	0.55	329.0
	MEAN =	1.87	SDV =	
HI-RAISE	DUR	NO.	TC	NO.
INC	1.49	161.00	0.41	166.0
DEC	1.62	166.00	0.59	167.0
	MEAN =	1.82	SDV =	
LO-LOWER	DUR	NO.	TC	NO.
INC	1.57	142.00	0.47	144.0
DEC	1.59	141.00	0.55	144.0
	MEAN =	1.85	SDV =	

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R NT CONDITIONING

	MAG	NO.	SLOPE	NO.	DI/DC
0	0.63	323.00	0.83	337.00	0.505
0	-0.63	326.00	-0.78	331.00	
0.64	NO. =	11699.09			
	MAG	NO.	SLOPE	NO.	DI/DC
0	0.51	166.00	0.75	170.00	0.479
0	-0.52	167.00	-0.68	168.00	
0.47	NO. =	5377.99			
	MAG	NO.	SLOPE	NO.	DI/DC
0	0.39	144.00	0.48	152.00	0.496
0	-0.39	141.00	-0.43	144.00	
0.35	NO. =	5111.99			

VARIABLE - HEART RATE

TABLE 3 Concluded

REST	DUR	NO.	TC	NO.	MAG	N
INC	1.48	314.00	0.75	635.00	19.15	32
DEC	1.99	306.00	0.99	623.00	-19.20	31
	MEAN =	90.58	SDV =	12.99	NO. =	116
HI-RAISE	DUR	NO.	TC	NO.	MAG	N
INC	1.49	148.00	0.78	151.00	16.61	15
DEC	1.97	144.00	1.04	148.00	-16.80	14
	MEAN =	94.42	SDV =	10.22	NO. =	53
LO-LOWER	DUR	NO.	TC	NO.	MAG	N
INC	1.34	150.00	0.67	150.00	18.11	15
DEC	1.94	145.00	0.95	149.00	-18.68	14
	MEAN =	85.88	SDV =	9.99	NO. =	5

NO	SLOPE	NO.	LAT	NO.
21.00	44.22	323.00		
13.00	-45.73	322.00		
634.09				
NO.	SLOPE	NO.	LAT	NO.
50.00	38.97	152.00	0.00	0.00
46.00	-38.60	148.00		
577.99				
NO.	SLOPE	NO.	LAT	NO.
50.00	43.45	150.00	0.00	0.00
48.00	-44.43	151.00		
111.99				

RESULTS

Preliminary Analyses. The first step in the analysis of the results was to inspect the frequency distributions for each parameter over all subjects from the summary output, employing a special statistical program developed at Lafayette Clinic. Data values that exceeded 3 standard deviations from the mean, were identified by a data dump and the values were checked against the original polygram. If values were found to be erroneous, either the correct values were computed and inserted or, if the correct value could not be obtained, a missing value code was inserted. Most of these errors found were traced to errors in editing.

Examples of extreme values not due to editing errors were palmar skin conductance (SC) values for 5 subjects which at times were in excess of 75 micromhos whereas the mean SC is about 23 micromhos. The polygrams and laboratory log was carefully scrutinized to seek some rational explanation. No apparatus or electrode malfunction could be found. Other subjects, from other studies with normal SC values had been interspersed between those with abnormal values which argues against any apparatus malfunction. Our present conclusion is that a combination of the high salt concentration of the electrode paste (Redux) and the constant voltage method employed in our apparatus which permits current values to rise as skin conductance rises may for some subjects with high initial conductance levels lead to currents high enough to maintain and increase electrophoresis of sodium ions so that still higher abnormal conductance values are produced in a positive feedback "snow balling" effect. Special research is under way to test this hypothesis and devise a method free from this defect. For this O.E. study these abnormal values of SC have been treated as artifact and edited out thus effectively preventing them from distorting the distributions.

No variable of interest had to be discarded because of error or distortions of the distributions although the number of subjects was reduced for some parameters. Having nearly 2000 parameters (variables in the statistical sense) to choose from, some efficient method of selection had to be applied. It has been shown by Paul Horst that factors provide superior prediction of a criterion from large sets of test variables than does any set of variables of comparable size. At the Lafayette Clinic Computing Service, the factor analysis computing program was limited to 50 variables. We chose the strategy of doing several factor analysis employing sets of variables with some overlap in each to help serve as marker variables for the main factors found. The type of FA employed was principle axes with Varimax, an orthoganal rotation method (Harman, 1960).

Factors with quite substantial loadings were found with obvious relevance to our hypotheses (for example, see Tables 4 and 5). Using these factors we wanted to compute the multiple regression for grades and achievement, testing whether high and low achievement groups could be identified and with what degree of significance. Achievement scores were defined as the residuals of grades regressed or I.Q. Those residuals falling above the

TABLE 4

FACTOR LOADINGS FOR FA3B*

	Description***				Rotated Factor Loadings				
	Variable	(1)	(2)	(3)	1	2	3	4	5
1	173	HR	R1	MAG D	024	-236	-079	-961	008
2	174	HR	R1	MAG D N	-059	137	928	201	001
3	165	HR	R1	MAG I	-026	233	126	957	-009
4	166	HR	R1	MAG I N	-003	121	951	043	-030
5	790	SC	R1	MAG I N	161	851	055	189	-090
6	974	SP	R1	MAG D N	090	837	115	138	003
7	966	SP	R1	MAG I N	002	854	129	134	-183
8	825	SC	OR Tone	Standard Dev.	958	087	-065	-026	-155
9	848	SC	OR Pain	Standard Dev.	792	116	-029	-044	-340
10	1647	MT	PAIN	MAG** I	630	-101	005	005	-176
11	1637	SC	PAIN	MAG** I	530	117	006	016	-635
12	808	SC	OR Tone	MAG I	937	118	-106	-026	-195
13	831	SC	OR Pain	MAG I	492	070	057	-128	-440
14	847	SC	OR Pain	SUM	645	445	022	132	-004
15	887	SC	PAIN	MAG D	-358	-154	-036	-026	687

* All variables are from the classical conditioning session.

** These magnitude means were computed with absence of response in an epoch treated as a response of zero (0.0) magnitude.

*** (1) Physiological variable name; (2) epoch type from which measurement was taken; (3) parameter measured: MAG is mean response magnitude for an epoch type, SUM is mean level of the variable over all epochs of a type, D indicates decrement, I indicates increment, N indicates frequency of I or D.

TABLE 5 FACTOR LOADINGS FOR FA9B.

	VARIABLE	DESCRIPTION* (1)	(2)	(3)	(4)	1	2	3	4	ROTATED FACTOR LOADINGS 5	6	7
1	1401	OC	HR	SUM	HI-LO	258	-204	-037	206	-048	-235	-185
2	1461	OC	FP	D N	HI-LO	312	002	133	-318	087	070	229
3	1466	OC	FP	I N	R-LO	-175	210	005	-206	-051	079	126
4	1460	OC	FP	SUM	R-LO	-129	-014	-328	337	-396	-110	-110
5	1443	OC	SC	I N	HI-LO	925	039	-146	-012	032	-131	002
6	1479	OC	SC	D N	HI-LO	902	044	-127	045	-051	-259	036
7	1482	OC	SP	I N	HI-LO	879	-083	-147	005	015	-167	-110
8	1484	OC	SP	I N	R-LO	065	060	-086	-073	818	-063	-106
9	1487	OC	SP	D N	R-LO	-066	118	064	-007	836	-108	046
10	1448	OC	FP	SUM	R	031	981	-136	-076	058	-052	045
11	1452	OC	FP	SUM	HI	025	982	-134	-080	063	-047	050
12	1456	OC	FP	SUM	LO	035	981	-128	-084	068	-049	048
13	790	OC	SC	I N	R	109	159	-053	007	098	-914	105
14	809	OC	SC	I N	HI	533	088	-161	040	-193	-759	062
15	842	OC	SC	D N	LO	211	079	-075	056	-198	-861	116
16	966	OC	SP	I N	R	137	-015	-031	-094	262	-699	-129
17	977	OC	SP	SUM	R	-162	-126	968	073	098	024	016
18	998	OC	SP	SUM	HI	-176	-141	959	060	086	012	044
19	1037	OC	SP	SUM	LO	-150	-140	963	044	092	038	040
20	283	CC	HR	MAG D	HI TONE (CR/)	045	159	-104	-017	-111	263	029
21	1517	CC	SP	MAG I	HI-LO TONE (Discr.)	-036	-006	-319	-066	-474	-003	061
22	1514	CC	SP	MAG D	HI-LO TONE (Discr.)	-033	-054	-279	-125	108	-055	171
23	1301	16PF-L			Suspiciousness	-036	110	-130	054	169	-169	438
24	1369	EPI-A			Motivation to succeed	-072	035	093	819	-024	025	077
25	1372	EPI-D			Plans work efficiently	081	-189	110	804	-025	049	001
26	1375	EPI-G			Articulate	118	-112	086	469	034	013	-088
27	1376	EPI-H			Feels Superior	-099	082	-047	-055	-102	060	657
28	1379	EPI-K			Self-Centered	028	099	046	090	-006	105	703
29	1381	EPI-M			Independence of Opinion	123	-093	086	-075	-190	-111	526
30	1382	EPI-N			Hard Worker	028	-077	004	779	047	060	027
31	1383	EPI-O			Neat in Dress	-102	054	-043	521	-078	-096	016

*(1) OC indicates operant and CC indicates classical conditioning; (2) Physiological variable name; (3) Parameter measured: MAG is mean response magnitude for epoch type, SUM is mean level of variable over all epochs of a type, D indicates decrement, I indicates increment, N indicates frequency of I or D. (4) HI, LO, and R indicate epoch types, singly; or in combination, e.g., HI minus LO.

regression line are positive and represent better grades than was predicted by I.Q., and those falling below the regression line are negative and represent underachievement (Table 6). Of the 99 subjects 50 were defined as low achievers and 49 as high achievers. The 50 subjects whose grades were below the mean were identified as the low grade group and those whose grades were above the mean as the high grade group (Table 7).

Achievement Group Differences. The low achievement and low GPA groups had 44 cases in common and the high achievement and high GPA groups had 43 subjects in common. The correlation between achievement and GPA was .856 indicating about 73% of the variance in common. These two ACH groups were then compared on 96 operant conditioning, 38 classical conditioning, 32 psychological and 64 factors by t-tests of their group mean differences. The 64 factors came from 9 factor analyses of which 15 factors were composed of 43 physiological variables from the classical conditioning session, 26 factors composed of 127 operant conditioning variables and 23 factors composed of 119 psychological variables. Some of these variables were common to two or more factor analyses and many were variables for which separate t-tests were done on the variables themselves as well as the factor scores computed from the factor loadings and raw scores. Thus it is rather difficult to compute how many independent group mean t-tests were done. But even if all the t-tests are added together they total 230 which would only produce about 12 significant by chance. Since 44 significant differences (Table 8) were found between low and high achievement groups, we feel confident at least 32 of them are probably significant. The variables that produced significant group differences are, of course, essentially the same ones that produced significant correlations (Table 9) with the ACH criterion variable. Since over twice as many t-tests were computed as correlations with ACH, there were naturally more significant t-tests found, 44 as compared to 24 significant correlations with ACH.

We regret that there was simply not enough computing time available to exhaustively compute either all the inter correlations or all the group mean differences for all variables. Since a rather detailed discussion of the variables with significant correlations with GPA and ACH follows in the next section, no further analysis of these ACH group differences will be made.

Employment of the 13 most discriminative factors and 3 physiological variables from inspection of the correlations in a multiple regression accounted for 39.4% of the variance in ACH. A discriminant function based on these 13 factors and three variables correctly discriminated 73 cases or 73.6% correct. We feared these results may have been weakened (1) by being based on less data than was actually available since for the factor analyses not all subjects could be included and (2) possibly because each factor inevitably was diluted with the variables which did not correlate with the criterion.

Specific Discussion of Significant Correlations With ACH and GPA

Accordingly next was tried the more direct approach of selecting all variables which correlated with the criterion--achievement--significantly (.05 or better). Of the 27 significant correlations (Table 9)

TABLE 6

	LO ACHIEVERS (GROUP 1, N = 50)		HIGH ACHIEVERS (GROUP 2, N = 49)	
	S NO.	RESIDUAL	S NO.	RESIDUAL
1	1	-1.27	2	.879
2	11	- .598	3	.586
3	14	- .427	4	.994
4	16	- .817	5	.814
5	17	- .0794	6	.850
6	18	- .8	7	.956
7	29	- .157	8	1.41
8	32	- .0703	9	.372
9	33	- .110	10	.914
10	34	-1.34	12	.108
11	35	-1.28	13	.0631
12	36	- .341	15	.0924
13	38	- .310	19	.462
14	41	- .303	20	.843
15	43	-1.25	21	.381
16	45	- .364	22	.369
17	49	- .195	23	.288
18	51	-1.12	24	.159
19	58	- .711	25	.308
20	60	- .522	26	.521
21	61	- .290	27	1.06
22	63	- .262	28	.504
23	64	- .684	30	.117
24	65	- .144	31	.0817
25	66	- .253	42	.530
26	69	- .693	44	.558
27	70	- .693	46	1.01
28	71	- .333	47	.516
29	75	- .00787	48	.329
30	77	- .816	50	1.46
31	79	- .101	52	.365
32	80	-1.10	53	.248
33	81	- .703	54	1.44
34	82	- .532	55	.508
35	84	- .958	56	.874
36	85	- .510	57	.910
37	87	- .464	59	.536
38	92	- .253	62	.431
39	93	- .887	72	.355
40	96	-1.10	73	.245
41	97	- .424	76	.715
42	98	-1.32	78	.482
43	100	- .276	83	.351
44	101	- .205	88	.475
45	102	- .465	90	.0676
46	103	- .369	91	.113
47	104	- .413	94	.308
48	105	- .925	95	.736
49	106	- .294	99	.0381
50	680	- .191		

TABLE 7

LOW GRADE POINT AVERAGE
(GROUP 1, N = 50)

S NO.	GPA	S NO.	GPA
1	0.900	65	1.263
11	1.250	69	0.750
14	1.421	70	0.750
16	0.700	71	1.000
18	1.600	72	1.615
22	1.666	75	1.105
24	1.714	77	0.333
25	1.642	80	1.333
29	1.250	81	1.071
31	1.636	82	1.500
32	1.300	84	1.111
33	1.333	85	0.933
34	0.428	87	1.200
35	0.381	93	1.071
38	0.913	96	0.526
41	1.545	97	1.461
43	0.777	98	0.777
45	1.300	99	1.666
49	1.285	100	1.388
51	0.170	102	0.500
58	0.916	103	1.111
60	1.363	104	0.846
61	0.933	105	1.291
63	1.181	106	1.333
64	1.090	680	1.142

HIGH GRADE POINT AVERAGE
(GROUP 2, N = 49)

S NO.	GPA	S NO.	GPA
2	3.500	47	2.733
3	2.692	48	2.619
4	3.100	50	2.727
5	2.700	52	2.214
6	2.625	53	2.318
7	3.062	54	3.625
8	2.714	55	2.136
9	2.000	56	2.833
10	2.285	57	2.428
12	1.736	59	2.091
13	2.353	62	1.875
15	2.272	66	2.000
17	1.769	73	1.800
19	2.421	76	2.086
20	2.629	78	2.000
21	2.083	79	1.857
23	1.769		
26	2.444	83	2.200
27	2.583	88	2.545
28	2.500	90	2.100
30	2.076	91	3.167
36	1.875	92	2.000
42	2.636	94	2.083
44	2.444	95	2.438
46	2.789	101	1.937

TABLE 8

VARIABLES WITH SIGNIFICANT ACHIEVEMENT GROUP MEAN DIFFERENCES

VAR. NO.	VARIABLE NAME	LO	HI	t	PROB.
	PSYCHOLOGICAL VARIABLES				
1301	16PF-L Suspiciousness	4.23	3.47	2.065	.05
1369	EPI-A Motivation to succeed	17.30	20.22	2.670	.01
1372	EPI-D Plans work efficiently	18.88	22.50	2.508	.01
1375	EPI-G Articulate	10.16	11.93	1.788	.05*
1376	EPI-H Feels superior	11.62	9.93	2.194	.05
1379	EPI-K Self-centered	8.68	6.74	2.527	.01
1381	EPI-M Independent in opinion	5.26	4.56	1.804	.05
1382	EPI-N Is a hard worker	15.82	17.64	1.924	.05
1383	EPI-O Neat in dress	7.42	8.25	2.20	.05
1292	McClelland N-ACH	3.28	4.29	.884	NS**
1384	Object Sort Pathological Signs	2.17	2.67	1.299	NS**
FA5B-1	EPI Motivation A B C D E F I N	-.27	.27	2.681	.01
FA5B-4	EPI B-Status, C-Recog, F-Compet, K-Self Cent.	.17	-.17	2.327	.05
FA9B-4	EPI Motivation A D N O	-.30	.31	3.207	.01
FA9B-7	EPI H feels superior, M-Indep, 16PF-L Suspicious	.34	-.37	3.487	.01
	PHYSIOLOGICAL VARIABLES FROM C.C.				
283	HRD High Tone, CR+ (Dec Scored Neg.) C.C.	-8.63	-9.93	1.777	.05*
1514	SP-D1 H-L Tone Disc. C.C.	.07	-.45	2.160	.05
1517	SP-I1 H-L Tone Disc. C.C.	.19	1.41	1.701	.05*
FA1-3	Respiration Period (CR_+-CR_0) Disc. C.C.	-.22	.23	1.898	.05*
	PHYSIOLOGICAL VARIABLES FROM OP.C.				
435	FPI (Time Constant Rest)	2.18	2.47	2.488	.01
790	SC I N R	49.45	33.82	2.007	.05
798	SC D N R	28.76	13.21	2.385	.05
809	SC I N H	29.34	19.52	2.110	.05
819	SC D N H	19.39	8.73	2.532	.01
842	SC D N L	11.97	6.50	1.914	.05*
966	SP I N R	25.37	17.26	1.764	.05*
977	SP SUM R	-26.49	-21.21	1.998	.05*
998	SP SUM H	-26.96	-21.51	2.046	.05
1037	SP SUM L	-26.58	-21.15	2.061	.05
1448	FP SUM R	-367.89	-1039.27	2.902	.01
1452	FP SUM H	-372.34	-1047.34	2.919	.01
1443	SC I N H-L	.75	.29	2.140	.05
1456	FP SUM L	-360.56	-1041.89	2.947	.01
1460	FP SUM R-L	7.31	2.62	2.128	.05
1461	FP D N H-L	.18	-.07	2.353	.05

TABLE 8 (continued)

VAR. NO.	VARIABLE NAME	LO	HI	t	PROB.
	PHYSIOLOGICAL VARIABLES FROM OP.C.				
1466	FP I N R-L	.27	.04	2.080	.05
1479	SC D N H-L	.75	.20	2.514	.01
1482	SP I N H-L	.57	.28	1.757	.05*
1484	SP I N R-L	.10	-.10	1.988	.05
1487	SP D N R-L	.27	.01	2.228	.05
FA7B-1	SC N R,H,L	.17	-.17	1.819	.05*
FA7B-9	SP SUM R,H,L	-.28	.31	1.987	.05
FA8B-3	SC I N, D N; SP I N, D N R-L	.23	-.22	3.372	.01
FA9B-1	SC I N, D N; SP I N H-L	.21	-.20	2.176	.05
FA9B-3	SP SUM R,H,L	-.05	.06	2.840	.01
FA9B-5	SP I, D N R-L	.11	-.12	1.739	.05
1401	HR SUM H-L	1.84	2.74	1.658	NS**

*Starred variables are significant at the .05 null prob. level for a 1 tailed t-test

**These 3 variables were included to show the trend of the group differences although they were not statistically significant.

TABLE 9

VARIABLES WITH CORRELATIONS SIGNIFICANT WITH EITHER GPA OR ACH

Psychological Variables

No. of Var.	Name of Variable	GPA r	ACH r
	Achievement	.856	---
1368	Full WAIS I.Q.	.451	-.023*
1369	Edwards Personality Inventory (EPI) A. motiv. to succ.	.169*	.204
1372	EPI-D Plans Work Efficiently	.247	.262
1382	EPI-N Is a hard worker	.249	.234
1383	EPI-O Neat in dress	.152*	.197
FA9B-4	EPI - A D N O	.273	.312
1379	EPI-K Self-centered	-.308	-.222
1381	EPI-M Independent in opinion	-.286	-.162*
1302	16PF-M Imagination	-.161*	-.200
FA9B-7	EPI-H,K,M, 16PF-L Suspicious (H=feels superior)	-.311	-.246
1291	Locus of Control C + E	.215	---
1412	Awareness of contengency in C.C.	.228	---
	Physiological Variables from Classical Conditioning		
701	MT Mag I pain C.C.	-.195	---
808	SC Mag I O.R. to C.S. C.C.	-.210	---
877	SC Mag I Pain C.C.	-.225	---
FA3B-5	SC Low Mag I to pain	.217	.203
1514	SP Mag D. Disc.(CR_+-CR_o) (Dec Scored neg)	-.093*	-.203

(Table 9 continued on next sheet)

Table 9
(continued)

Physiological Variables from Operant Conditioning

No. of Var.	Name of Variable	GPA r	ACH r
1037	SP SUM R	.223	.223
998	SP SUM H	.233	.231
FA9B-3	SP SUM R, H, L	.204	.271
1448	FP SUM R	-.304	-.349
1452	FP SUM H	-.308	-.352
1456	FP SUM L	-.309	-.354
1460	FP SUM R - L (FP scored neg)	.277	.273
790	SC IN R	-.216	-.229
809	SC IN H	-.261	-.265
832	SC IN L	-.237	-.212
1443	SC Mag. I N H-L	-.220	-.259
1479	SC Mag. D N H-L	-.253	-.257
1482	SP Mag. I N H-L	-.195	-.172*
1487	SP Mag. D N R-L	-.166*	-.220
FA9B-1	SC + SP N H-L	-.222	-.207
1401	HR SUM H-L	.186*	.190*

** Achievement scores are residuals of GPA regressed on I.Q.
* Correlations starred are not significant but filled in for comparison. All other correlations in table are significant at least at the null probability of .05 or less with 2 tailed test.
- Indicates that particular correlation has not been computed.

found with GPA (not counting achievement) nine were with psychological variables, four with classical conditioning variables and 14 with operant conditioning variables. As one would expect the correlations were very similar with GPA and ACH since GPA and ACH are highly dependent (r=.856), ACH being the variable composed of residuals of GPA regressed on I.Q. Three additional psychological variables were significantly correlated with achievement--16 PF M (imaginative), Edwards Personality Inventory (EPI) scale A (Motivation to Succeed), and EPI -O (Neat in Dress).

EPI (independence of opinion) which correlated with grades did not reach significance with ACH. Of course I.Q. is uncorrelated with achievement since the ACH scores are equally distributed above and below the regression line.

The motivation scores of the EPI-D (plans work efficiently) -N (is a hard worker), -O (neat in dress), and the motivation factor FA9B-4, composed of EPI scales A,D,N, and O are easy to understand as contributing to good grades. EPI scales -K (self centered), -M, (independence of opinion) and the factor, FA9B-7, composed of EPI scales -H (feels superior), -K (self centered), -M (independence of opinion) and 16 PF-L (suspiciousness) are not difficult to conceive of as likely to interfere with earning good grades in the social intellectual climate of many students in this inner city school at that time. These two variables negatively correlated with grades and achievement could represent a rejection of the school establishment with self esteem related more to non-school values.

The negative correlation between grades and 16 PF scale M (imaginative) is at first glance surprising since imagination should be a positive factor in scholastic achievement. It is possible that higher levels of imagination, perhaps without sufficiently strong achievement abilities or attitudes could lead to day dreaming, less practical consistent application to the teacher's demands, and thus result in lower grades than the I.Q. would predict. In our previous study, (Ax and Bamford, 1968) 16PF-M was highly discriminative ($p<.01$) between the high and low motivation groups in favor of the high motivation group. Whether this opposite finding for the two studies is due to differences in the student populations, differences in teacher attitudes and grading policies or simply a statistical aberration cannot be determined at this time. Because of other differences in our findings between these two studies we suspect rather fundamental differences in the two populations and that the teacher ratings of motivation for the Skills Center Study differed considerably from the GPA criterion of this study.

Only one physiological variable -- low SC response to pain from factor FA3B-5--from the classical conditioning session--was significantly positively correlated with GPA and only one additional one--SP Disc Mag D1 (i.e., magnitude of CR+ -CRo for decrements)--correlated significantly with ACH. This SP palmar sweating score is a major classical conditioning discrimination score similar to those found highly discriminatory for the previous study (Ax and Bamford, 1968) and of course, in the same expected direction with superior discrimination learning of this palmar sweating response positively correlated with higher achievement.

The negative sign (r = -.203) of the correlation merely reflects the fact that decrements in SP are the sweating response and are scored as negative. Thus larger negative scores represent larger differences between the pain reinforced CR+ and the non-reinforced CRo. The factor FA3B-5 loaded by SC palmar sweating low magnitude of response to the UCS, pain, being positively correlated with achievement suggests that the high achieving group has a more restrained or relaxed attitude toward the pain stimulus. The three significant negative correlations with GPA (which were not computed for the ACH score)--magnitude of response of SC to the first tone (OR), to pain, and of frontalis muscle tension to pain--all support the fact that the low GPA group responded more vigorously with less control than did the high GPA group. This finding supports the other evidence of less GSR lability among the high achieving groups and their personality scores of greater control and stability. These high achieving students who have not dropped out and are finishing their senior year in high school may be as motivated as were our higher motivated group of the Skills Center but are also better organized and controlled. The Skills Center group had previously failed or dropped out of school but now with added incentive of a second chance were finally succeeding by extra effort but probably they still perform with less calm control. From this viewpoint it may well be that our classical conditioning paradigm and the rather mild pain stimulus as the UCS was barely sufficient to test this basic limbic learning aptitude by classical conditioning so successful in the lcwer achieving Skills Center groups.

In contrast to our meager findings with classical conditioning in this present study, operant conditioning was much more prolific with significant findings. Operant conditioning consisted of 10 one minute trials during which S was asked to speed up his heart rate and 10 trials during which he was asked to lower his HR. These 20 trials were presented in a pseudo random order and were interspersed with 1 minute rest periods. A cardiotachometer meter visually displayed to S his HR in a continuous analog fashion except during rest periods. Although HR was the variable of attention and feedback it just failed to reach statistical significance in correlation with GPA or ACH. We find, however, that many other autonomically controlled variables tend to be influenced and respond more or less during HR conditioning. The total organism is being conditioned, not merely his HR. It is true, of course, that with long continued practice with only one variable reinforced, gradual differentiation is achieved as it is with skeletal behavior skills. Thus with this brief period of practice we are not surprised that several ANS variables also revealed evidence of conditioning and produced significant correlations with GPA and ACH. It was with this expectation that they were recorded and analyzed.

The three SP variables with positive correlations with GPA and ACH indicate that a more positive skin potential (less sweating arousal) is directly related to ACH during the operant conditioning session. This more relaxed level of palmar sweating in the high achieving groups is consistent with the lower frequency of SC and SP responses as indicated

by the negative correlations with GPA and ACH for variables[1] SC N I R, H, L; SC N, I and D, H-L; SP N I H-L and D R-L; and the factor FA9B-1 which is loaded with frequency of SC and SP H-L responses. The finding for FP-- the index of finger skin vasoconstriction--is quite the opposite. Since FP is a negative going variable scored so that smaller or negative values represent vasoconstriction it is clear that the negative correlations of FP with GPA and ACH indicate a positive relationship between finger vasoconstriction and achievement. Even the FP SUM Rest - Low positive correlation with GPA and ACH indicates that the high achievers constricted more during their effort to lower HR than did the underachievers. Thus we see a situation where the high achievers while trying to control their HR do not generalize to palmar sweating but focus their effort on their cardiovascular system, operating from a more relaxed sweating level but making larger vascular constrictions. This finding raises a very interesting problem: Why did not the high achievers succeed in raising their HR relative to their vasoconstriction significantly more than did the low achievers? Actually they came very close to doing so. The mean HR difference between H-L for high achievers was 2.74 beats/minute, whereas for low achievers it was 1.84 a difference whose t-test value came within .01 of reaching the null prob of .05 for a one-tailed test. With only 20 trials of this novel task it is indeed not surprising that differentiation within the cardiovascular system was not significantly achieved. In fact their success in raising HR may have been attenuated by this tendency to generalize to excessive vasoconstrictive and probably BP rise. There is a physiological compensatory mechanism which lowers HR when BP gets too high. We have only half the evidence to test this hypothesis of HR rise attenuation by vasoconstriction because unfortunately no BP recordings were made during the operant conditioning. Such a finding of intellectually achieving persons using vasoconstriction rather than increased HR during an unfamiliar effort is quite in line with evidence from such high achieving clinical types as essential hypertension and migraine headache sufferers; but, of course, there is no suggestion here that these high achieving students are heading toward psychosomatic pathology. It may only be a widespread tendency among many humans and worthy of further study.

In summary of this section then it was found that the higher achieving students operate from a more specifically relevant physiological arousal (cardiovascular), dissapate less of their effort in remote physiological systems (sweating) but bear down more vigorously with their vascular constriction which may have interfered with their full potential to control their HR. With more practice their aptitude and motivation might well have enabled them to progress further in this subtle differentiation required within the cardiovascular system.

Multiple Regression and Discriminant Analyses for ACH and GPA

After eliminating, to the extent possible, the overlapping scores obviously highly correlated with each other, 19 variables were used in a

[1] N means number of increments (I) or decrements (D) during the rest (R) high (H), or low (L) epochs. SUM means the ave. level of the variable during the R, H, or L epochs.

TABLE 10

REGRESSION ANALYSIS FOR ACHIEVEMENT

Var Order	Var No.	Variable Name	CUM R^2	Δ R^2 PHYS	Δ R^2 PSY
1		ACH -- Dependent Variable			
2	1456	FP SUM L OPC	.1087	.1087	
3	1460	FP SUM R OPC	.1661	.0574	
4	809	SC IN H OPC	.2237	.0576	
5	FA9B-7	EPI-H,K,M; 16PF-L (Removed)	.2572		.0335
6	998	SP SUM H OPC	.2876	.0304	
7	1302	16PF-M Imaginative	.3086		.0210
8	FA9B-4	EPI-A, D, N, O MOTIV.	.3380		.0294
9	1487	SP D N R-L OPC	.3538	.0158	
10	1379	EPI-K Self-centered	.3630		.0092
11	FA9B-3	SP SUM R, H, L OPC	.3728	.0098	
12	790	SC N I R OPC	.3858	.0130	
13	1382	EPI-N Hard worker	.3959		.0101
14	FA3B-5	SC - Low Mag I, Pain OPC	.4044	.0085	
15	1383	EPI-O Neat in dress	.4100		.0056
16	1369	EPI-A Motivation to succeed	.4115	.....	.0015
17	1443	SC Mag I N H-L OPC	.4128	.0013	
18	FA9B-1	SC + SP N H-L OPC	.4133	.0005	
19	1514	SP DI Hi-Low Tone cc (not used)			
20	1372	EPI-D Plans work efficiently (not used)			

Percent variance of ACH accounted for by OP Cond. Phys. Var. 30.3%

Percent variance of ACH accounted for by Psychol. Var. 11.0%

multiple regression to predict achievement. The step-wise regression analysis (Anderson and Bancroft, 1952; Efroymson, 1960) selected 16 of the 19 variables with a multiple R of .6429. R^2 was thus .4133 which measures the amount of the variance in the achievement scores accounted for by the 16 variables. The tolerance and critical F-values were set low (F to ADD = F to Remove = .01, TOL = 0.0). I.Q. was of course omitted from this calculation since I.Q. had made its contribution by helping to define achievement. These variables can readily be classified as psychological or physiological. From Table 10 it can be seen how much of the variance (R^2) of achievement each variable contributes. Operant conditioning accounted for 30.3%, and the psychological variables accounted for 11.0% of the variance in achievement, as ACH was defined by regressing GPA on I.Q.

It is of considerable interest to note that 30.3% of the variance in achievement is accounted for by our physiological measures whereas only 11% (about 1/3) is accounted for by the psychological tests (remembering that I.Q. is already taken out in computing the achievement scores.)

A similar analysis was done for grades now using I.Q. as one of the psychological variables. These results are posted in Table 11. Not surprising is that I.Q. is the largest single contributor, 20.4%, with the other psychological tests contributing another 9.1%. The physiological tests accounted for 21.3%. Thus the physiological tests are slightly more potent in predicting grades (21.3%) than is I.Q. (20.4%). But there are additional psychological tests that contribute another 9.1% of the variance in grades.

Taken as a totality our test battery (physiological and psychological) account for 50.9% of the variance in grades whereas I.Q. can only account for 20.4%. Thus our particular set of tests can predict grades about 2 1/2 times as well as can I.Q. alone.

Discriminant function analyses (Mahalanobis, P. C.; 1936; Rao, C. R., 1952) for these same sets of variables were computed. For the achievement groups 41 of 50 of the low group and 40 of 49 in the high achievement group were correctly classified which is 82.4% correct prediction (Table 12). For the high and low GPA groups the discriminant functions correctly identified 42 of the 49 in the high group, and 42 of the 50 in the low group correct which is 84.8% correct (Table 13). Such predictions are of course highly significant by a Chi Square test. (D^2 as X^2 = 58.528 and 70.092, respectively, with 19 *df*). Only variables which were each individually significantly correlated with achievement (for the Achievement D.F.) or with grades (for the GPA D.F.) were employed in these discrimination analyses. Thus there is reason to believe that there would be substantial replicability if these variables were applied to another similar sample of high school students.

TABLE 11

REGRESSION ANALYSIS FOR GPA

Var Order	Var No.	Variable Name	CUM R^2	Δ R^2 PHYS	Δ R^2 PSY
1		G.P.A.			
2	1368	I.Q. Full WAIS	.2044		.2044
3	1456	FP SUM L OPC	.2790	.0746	
4	1460	FP SUM R-L OPC	.3316	.0526	
5	FA9B-7	EPI-H,K,M, 16PF-L (Removed)	.3847		.0531
6	1479	SC ND H-L OPC	.4192	.0345	
7	1382	EPI Hard worker	.4422		.0230
8	FA3B-5	SC Low mag to pain OPC	.4689	.0267	
9	998	SP SUM H OPC	.4837	.0148	
10	FA9B-3	SP SUM R,H,L OPC	.4892	.0055	
11	1379	EPI Self centered	.4968		.0076
12	1381	EPI Independence in opinion	.5033		.0065
13	832	SC NI L OPC	.5055	.0022	
14	790	SC NI R OPC	.5080	.0025	
15	809	SC NI H OPC	.5083	.0003	
16	1372	EPI Plans work efficiently	.5085		.0002
17	FA9B-4	EPI- A D N O Motivation	.5089		.0004
18	1443	SC NI H-L OPC (not used)			
19	1482	SP NI H-L OPC (not used)			
20	FA9B-1	SC + SP N H-L OPC (not used)			
				.2137	.2952

Psychological variables accounted for 29.52% of the variance in GPA of which 20.44% was I.Q. and 9.08% was EPI scales. Physiological variables accounted for 21.37% of the variance in GPA of which 18.70% was from Operant Conditioning and 2.67% was from Classical Conditioning variables.

TABLE 12

DISCRIMINANT FUNCTION ANALYSIS FOR ACHIEVEMENT

LOW ACHIEVEMENT GROUP			HIGH ACHIEVEMENT GROUP		
S-No.	L-GP PREDICTION	H-GP PREDICTION	S-No.	L-GP PREDICTION	H-GP PREDICTION
1	.371*	.628	1	.431	.568
2	.939	.060	2	.129	.870
3	.508	.491	3	.015	.984
4	.786	.213	4	.002	.997
5	.429*	.570	5	.368	.613
6	.466*	.533	6	.013	.968
7	.578	.421	7	.062	.937
8	.731	.268	8	.043	.956
9	.207*	.792	9	.212	.787
10	.727	.272	10	.543*	.456*
11	.991	.008	11	.190	.809
12	.556	.443	12	.161	.838
13	.765	.234	13	.433	.566
14	.824	.175	14	.053	.946
15	.802	.197	15	.145	.854
16	.852	.147	16	.158	.841
17	.425*	.574	17	.423	.576
18	.241*	.758	18	.228	.771
19	.766	.233	19	.387	.612
20	.388*	.611	20	.506	.493*
21	.682	.317	21	.046	.953
22	.255*	.744	22	.950	.049*
23	.983	.016	23	.413	.586
24	.649	.350	24	.640	.359*
25	.929	.070	25	.113	.886
26	.717	.282	26	.335	.664
27	.957	.042	27	.227	.772
28	.783	.216	28	.346	.653
29	.979	.020	29	.540	.459*
30	.929	.070	30	.011	.988
31	.977	.022	31	.089	.910
32	.910	.089	32	.184	.815
33	.759	.240	33	.012	.987
34	.767	.232	34	.475	.524
35	.925	.074	35	.758	.241*
36	.200*	.799	36	.327	.672
37	.586	.413	37	.121	.878
38	.708	.291	38	.388	.611
39	.685	.314	39	.470	.529
40	.812	.187	40	.449	.550
41	.976	.023	41	.152	.847
42	.765	.234	42	.343	.656
43	.761	.238	43	.284	.715
44	.685	.314	44	.473	.526
45	.741	.258	45	.450	.549
46	.875	.124	46	.503	.496*
47	.504	.495	47	.694	.305*
48	.589	.410	48	.792	.207*
49	.826	.173	49	.207*	.850
50	.783	.216			
	41 of Low GP Correct			40 of High GP Correct	

81 Subjects Correctly Predicted as to Achievement Group is 82.4% correct by the 19 variables applied to the Regression Analysis.

TABLE #13
DISCRIMINANT FUNCTION ANALYSIS FOR GPA

LOW GPA GROUP S-No.	LOW GP PREDICTION	HIGH GPA GROUP S-No.	HIGH GP PREDICTION
1	.132*	1	.961
2	.924	2	.984
3	.605	3	.992
4	.590	4	.711
5	.192*	5	.917
6	.791	6	.986
7	.911	7	.941
8	.738	8	.666
9	.996	9	.667
10	.936	10	.761
11	.520	11	.718
12	.546	12	.704
13	.992	13	.913
14	.834	14	.981
15	.942	15	.886
16	.725	16	.848
17	.834	17	.307*
18	.636	18	.908
19	.425*	19	.036*
20	.831	20	.394*
21	.201*	21	.617
22	.925	22	.896
23	.638	23	.958
24	.942	24	.518
25	.669	25	.953
26	.648	26	.945
27	.900	27	.736
28	.799	28	.898
29	.893	29	.975
30	.994	30	.912
31	.936	31	.991
32	.140*	32	.789
33	.713	33	.567
34	.437*	34	.511
35	.941	35	.544
36	.559	36	.597
37	.782	37	.651
38	.558	38	.400*
39	.913	39	.196*
40	.907	40	.659
41	.343*	41	.569
42	.827	42	.856
43	.729	43	.708
44	.971	44	.900
45	.963	45	.824
46	.850	46	.716
47	.659	47	.395*
48	.956	48	.118*
49	.938	49	.857
50	.381*		

42 of low GPA GP correct. 42 of High GPA GP Correct.
84 subjects of 99 were correctly predicted as to GPA GP by the 19 variables supplied to regression analysis. 84.84% correct.

DISCUSSION OF FINDINGS

The finding that a battery of psychological and psycsiological learning and response variables accounts for about 50% of the variance in grades, whereas I.Q. (full WAIS) can only account for 20% indicates that variables are being examined which are important for earning grades and that they can be measured in a reasonable amount of time and cost. Probably more importantly than their prediction value is the fact that these particular variables were selected on the basis of a theory of motivation which has been neglected not only in educational research but in general psychological research as well. This theory states that a crucial factor in achievement is the aptitude for learning many social motives, among them is earning high grades in school, and that this aptitude can be measured by appropriate learning tasks for those functions controlled by the motivational systems of the individual. The limbic system is known to be the chief part of the brain which mediates motivation and emotional control so essential for sustained effort in achieving any goal. The motor system for the limbic system is the autonomic nervous system (ANS). Hence ANS functions are the appropriate behavior to examine for their sensitivity, range of response and capability to modify their response in terms of experience, that is, to learn.

The values of this theory of motivation are that it can provide the rationale for measuring, predicting, and understanding achievement in general. Any human achievement which requires sustained effort requires sustained motivation sufficient to overcome the obstacles, frustration and seduction of quicker gratification with less effort. Such motivation by which competence and goals can be achieved can only come from some genetic or constitutional aptitude combined with appropriate environmental opportunities for learning. Regardless of whether a current state of motivation is regarded as some vigorous physical-mental state not based on learning or whether a motivational state is believed to be primarily learned, the aptitude to become so motivated or to be able to learn to be so motivated must be a characteristic now or previously possessed by the person. If regarded as primarily learned then the aptitude for such learning must have been present previously during the learning stages. The particular competence a person acquires is clearly the resultant of the particular set of aptitudes and environmental learning and motivating influences to which he is exposed. The motivational theory herein being proposed is that there is a general aptitude to learn to be motivated. The extent to which the aptitude to be motivated and to learn to be motivated is general, the same for all types of achievement, or is specific to each type of behavior remains to be determined. The history of intellectual ability research suggests that motivational ability also will be found to have a general factor that can underlie most any successful endeavor and that there are more specific aptitudes to be motivated for various types of activities. Many examples from life illustrate the general component of motivation. Many people are quite successful at several quite different human achievements such as football, business, and politics; or conversely we have all known highly intelligent people who try one thing after another several of which fall clearly within their area of intellectual competence, yet fail at all of them. In-depth analyses of their histories of failure usually reveal a lack of persistant application over sufficient time

for success to be achieved. So often the presence or absence of early environmental incentives or rewards seem not to be determining in sustaining the human persistance in our activity. Rather there seems to be for the successful person an inner conviction of his ability to achieve against all odds; or conversely the person who consistently fails, discounts his small successes as meaningless and feels he doesn't have the ability to succeed. Most of us have experienced an analogous feeling when we mistakenly undertook some behavior for which we lacked talent. In competition with others who have such talent, say in music, art or mathematics, we quickly sense that we are fish out of water yet some of us who had high aptitude for motivation (as proven by later success in skills more appropriate for our special aptitudes) may have persisted for years in our misplaced effort to become a musician.

This theory of a general aptitude for motivation has enabled us to apply several well known techniques to its measurement. These are classical and operant conditioning (learning) of functions controlled by the ANS and hence, by the limbic system which is superordinate to the ANS. Historical inquiry by questionnaire, interview and other performance records are also of course useful evidence of sustained motivation. All three methods (classical and operant conditioning of ANS functions and psychological inquiry) have demonstrated their power to identify low motivational aptitude among mentally disturbed patients (Ax, et. al., 1970), underachievers in vocational school (Ax and Bamford, 1968) and in a public high school by this study. We believe the common factor in the underachievement of these three different groups of people was their low aptitude for limbic learning. For the schizophrenic patients this low aptitude was so severe as to preclude normal emotional development necessary for mature human relationships. For the school groups the low limbic aptitude being either less severe or being accompanied by different patterns of other aptitudes and/or environmental conditions, resulted not in severe mental or emotional disorder but rather in underachievement in their current chief life's work. Since both statistical and clinical evidence shows this limbic aptitude to be independent of I.Q. there is justification to postulate an additional aptitude important for achievement and emotional maturity.

The conditioning methods are applicable to humans of any age even neonates, thus the aptitude could be measured at the earliest ages and observed in its development. Early awareness and quantitative measures of limbic aptitudes could provide pediatricians, child psychologists, parents and teachers with valuable data to guide their handling of each child. Special educational programs can be devised for the various degrees of limbic aptitude found. One can suggest various corrections or preventive treatments, but these would of course require extensive research. Just as the skeletal sensory-motor system can be exercised and disciplined to reliable habits so can the limbic emotional and motivational sensory-motor (ANS) systems be trained and disciplined by deliberate programs of exercise employing known methods of reinforcement. Biofeedback of ANS functions is one new adjunct to such training.

It may be interesting to note which tests failed to contribute any significant discrimination between the criterion groups of the 85 variables intercorrelated with achievement and G.P.A: 27 correlated

significantly with achievement and 24 with G.P.A. Thus 58 did not correlate significantly with achievement and 61 failed for G.P.A. The physiological measures which either we had previously found to be significantly correlated with achievement or by hypothesis predicted would be but are not found in this study to be significantly correlated with either achievement or G.P.A. were: (1) finger pulse unconditioned response to pain, (2) classical conditional scores for HR, finger pulse, GSR, and frontalis muscle tension response. Psychological tests which failed to correlate with either achievement or G.P.A. were: (1) Social Economic Class, (2) Level of Aspiration test variables including the judgement error score, (3) scale G of the 16 P.F., and (4) Edwards scales "articulate" and "feels superior."

There are at least two possible explanations for these discrepancies with our previous results: (1) Either these particular discordant correlations are random fluctuations departing from the true population norms, or (2) the populations were sufficiently different to merit different results. Other tests that we used but didn't produce interesting factor loadings or significant criterion group differences so were not included in the correlation matrix were the Minnesota Counseling Inventory, Need for Achievement, Object Sorting test and Locus of Control. We cannot state with absolute certainty that if the correlations had been done between all these test scores and the two criterion variables of achievement and G.P.A. that none would have reached significance, since they were screened via the factor analyses which, as mentioned previously, did not seem quite as sensitive as did our direct correlation approach. The lack of obvious loadings on factors relevant to achievement on these 4 tests does strongly support our present findings that these tests (Minnesota Counseling Inventory, Need for Achievement, Object Sorting and Locus of Control) do not account for much of the variance in achievement or G.P.A. in this population. We are not surprised by the lack of discrimination by the MCI since our previous study (Ax and Bamford, 1968) had found no support for the hypothesis that the low achievers are more neurotic. The object sorting test was a surprising disappointment since we had assumed it would tap cognitive abstracting abilities that would be useful in earning grades but now in retrospect if this were a fact the object sort would be a standard part of I.Q. tests. The many recent reports on locus of control also had led us to expect a significant contribution to achievement, but possibly either the version we used (J. O. Miller) is not as sensitive or valid as Rotter's (see Rotter, 1960) or else the social desirability aspect of so many of the items destroys its validity when actual long-term behavior like earning good grades is involved.

Our greatest surprise and disappointment was the McClellan Need Achievement test (McClellan, 1958). Because of his impressive successes with it we are inclined to suspect that we did not sufficiently get the subjects involved and/or that we did not score the protocols with enough insight and sensitivity. If the opportunity arises that we could get one of Dr. McClelland's trained staff to rescore these *n Ach* protocols for us we would like to pursue it further.

More serious for our hypothesis than the failure of these several psychological tests was the very small percent of variance (about 3%) in achievement that was accounted for by our classical conditioning scores.

We are essentially at a loss to explain these results in view of the past power of the classical conditioning procedure. One possibility is that the classical conditioning of ANS variables is primarily sensitive to very low levels of limbic learning aptitude and that the H.S. seniors of this study having stayed in school this long and being motivated enough to participate in our study were above this critical level in contrast to those from the Skills Center study who had all dropped out of H.S. and the chronic schizophrenic patients of the earlier study who were of course much more seriously handicapped in terms of achievement. Another possibility is that our psychophysiology technicians who did the testing may not have watched for drowsiness as carefully as we did on the previous study. Boredom and drowsiness can seriously degrade classical conditioning. Careful questioning and the frequent observations which we did during the testing phase does not lend much support to this hypothesis. Only future research can clarify this point.

The outstanding contribution of 30% of the variance of the operant conditioning of heart rate and the associated pattern of ANS arousal achieved by the high achieving group is a new and substantial finding. As we suggested in our 1968 study we believed that operant conditioning would indeed be superior for predicting achievement because it would measure the limbic learning aptitude as well as the current motivation. Motivation and emotional aptitude tests are analogous to I.Q. tests for predicting intellectual achievement in school. Each type of aptitude test combines the measurement of a presumed original constitutional aptitude and the resultant skills and motives achieved through the interaction of that original aptitude and the environmental opportunities and incentives experienced in life up to this point.

The other gratifying finding is the substantial contribution of the Edwards Personality Inventory (8.9% of the variance for achievement). This demonstrates that a sophistocated self reporting inventory can elicit information relevant to achievement in addition to what I.Q. and psychophysiological tests can obtain. Future efforts to predict achievement should not omit this source of information.

The pattern of the 15 factors of the Edwards Personality Inventory tells an interesting story of what seems to contribute to achievement in H.S. and what prevents it. All the motivation and good work habits correlate in the expected directions. The high achieving groups have higher scores on motivation to succeed, desires recognition, plans work efficiently, is cooperative, articulate, logical, assumes responsibility, makes friends easily, is a hard worker and is neat in dress. Being impressed by status and competitiveness is irrelevant. Feeling superior, being self-centered and having independence of opinion were all higher in the low achieving group. Among this age group and possibly because of anti-establishment sentiment among many students during this period, it is not difficult to see that even without the social rewards of good grades these underachieving students may feel superior, be self-centered and believe themselves to have independence of opinion which may mean independence of their perceived establishement opinion. It is possible of course that these three characteristics of the underachieving group are reacted to by teachers in giving them lower grades; but then society

throughout their lives may also withhold rewards from them if they continue exhibiting these attitudes without sufficient of the other high motivation characteristics. Parents, teachers and counselors might well be able to employ this kind of finding in seeking to help their charges gain insight and change their attitudes more in harmony with circumstances of the real world. There is no suggestion implied that at times independence of opinion, feeling superior and even being self centered may not be appropriate and necessary when other compensatory qualities are also present.

CONCLUSION

The findings of this study of 99 inner city high school students support those of two previous studies by the senior author that autonomic learning and selected psychological tests of motivation correlate very significantly with criteria of achievement. In this study 50% of the variance in grades was accounted for: 20% by I.Q., 18.7% by operant conditioning of Heart Rate, 8.89% by psychological tests for motivation and 3.0% by classical conditioning and response of ANS functions to pain stress. For achievement, defined as the residuals of grades regressed on I.Q., about 41% of the variance is accounted for, distributed between autonomic conditioning (30%) and psychological tests of motivation (not including I.Q.) 11%. The marked superiority over classical conditioning of operant conditioning of Heart Rate employing instantaneous visual feedback for the reinforcement supports the notion that this learning paradigm tests limbic control of autonomic variables by employing continuous knowledge of performance. It simultaneously measures the ability of limbic control and the strength of current motivation elicited by the social incentive of the experimental situation. No financial or other rewards were given for better achievement. Thus about 3 hours of testing (1 hr. for I.Q., 1 hr. for operant control of heart rate and 1 hr. of Edwards type motivation questions would account for 50% of variance in grades. Refinement of the testing procedure and the use of a comprehensive school achievement test as the criterion rather than grades would probably further improve the correlations. Grades are known not to be a very precise or reliable measure of intellectual achievement, although the average over 3 years of high school must have considerable validity.

The results of these studies are substantial enough to justify the next obvious steps in research of achievement.

1. Replication of those tests procedures found most predictive on a non-inner city high school group should be done.

2. A predictive study of younger students is essential. Both future performance in high school and past grades could be correlated with experimental psycho-physiological variables.

3. Pre school or first grade evaluation should be done for a predictive study where the results could be put to the best use.

4. Those young children found deficient in motivational and emotional control variables could be treated by specific

training procedures of autonomic control and in practicing delayed gratification. Matched control groups of both motivationally deficient and non-deficient should be employed so as to sensitively test the value of the specialized motivational procedures in terms of future performance in grades, general adjustment and in psycho-physiological test performance.

5. A study should be done of infants by classical and operant ANS conditioning in which these aptitude variables would be correlated with future health and performance.

If these 5 programs were undertaken, within 5 to 10 years of follow up, our current theory of motivational aptitude would be thoroughly tested and programs for prevention and treatment could be based on a firm foundation of fact.

It is likely that both a general aptitude for motivation and emotional development as well as specific aptitudes of motivation will become differentiated. Motivational testing should have a greater impact on special educational practices than has I.Q. and the special sensory-motor impairments now being so well researched and treated. The concept of underachievement can fade away as the specific aptitudes and environmental factors are understood and measured. One does not speak of a child who has little musical talent as an underachiever in music; why should a child who has little aptitude for learning the social motives or emotional control be stigmatized as an underachiever either in school or in life. Once knowledge replaces ignorance, compassion and skilled educational methods can replace condemnation, punishment or neglect of the "Underachiever" in our society.

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Appendix

TABLE 1
POINTS OF INTEREST OUTPUT SAMPLE

IDENTIFICATION OF PI FILES OF CURRENT INTERE

FILE PROTECT CODE...	NO	STUDY.....	
ACCESSION.....	124	SESSION.....	
ANALOG TAPE.....	22	SUBJECT.....	
TIMES DIGITIZED.....	1	PI RUN.....	
SMOOTHED TAPE.....	0	PI TAPE.....	

NO.	VAR TITLE	ATOL	TTOLR
1	RESPIRATION	0.06000	0.4
2	CARDIOTACHOMETER	0.60000	0.2
4	FINGER PULSE DC	0.00070	1.4
5	MUSCLE TENSION	4.00000	1.0
6	SKIN CONDUCTANCE	0.25000	0.8
7	SKIN POTENTIAL	0.31000	0.8
10	TIME CODE (1.0/SEC)	0.50000	0.2

***IDENTIFICATION SUMMARY COMPLETE

TABLE 1

TS OF INTEREST OUTPUT SAMPLE

ON OF PI FILES OF CURRENT INTEREST

NO
124
22
1
0

STUDY	1
SESSION	1
SUBJECT	49
PI RUN	1
PI TAPE	1

ATOL	TTOLR	TTOLD	NO. PI
0.06000	0.4	1.5	2618
0.60000	0.2	2.0	2541
0.00070	1.4	3.0	447
4.00000	1.0	1.5	513
0.25000	0.8	3.0	128
0.31000	0.8	3.0	147
0.50000	0.2	0.2	9

TABLE 1 Continued

VARIABLE NO. 1 NO.PI FOUND WAS 2618 NO.PI

TIME	TYPE	AMPLITUDE	SUM,SMSO,SLOPE	TIME	TYPE	AMPLITUDE	SUM,SMSO,SLOPE	
26.8	EP1	2.2099	0.000E 00	74.9	LO	1.1854	-0.225E 00	1
27.2	RS	1.8199	-0.107E 01	76.0	RS	3.0317	0.289E 01	1
29.2	LO	1.0898	-0.109E 00	76.2	HI	3.49959	0.266E 01	1
30.0	RS	1.6897	0.134E 01	76.5	FS	2.7757	-0.272E 01	1
30.6	HI	2.2478	0.546E 00	77.9	LO	1.6578	-0.255E 00	1
31.3	FS	1.8177	-0.856E 00	79.4	RS	5.0456	0.479E 01	1
33.5	LO	1.1579	-0.878E-01	79.6	HI	5.6438	0.405E 01	1
34.3	RS	2.0435	0.153E 01	79.7	FS	5.1478	-0.336E 01	1
34.7	HI	2.4538	0.862E 00	79.8	LO	4.6935	-0.336E 01	1
35.5	FS	1.8776	-0.111E 01	80.0	RS	6.5156	0.803E 01	1
37.5	LO	1.1338	-0.357E-01	80.1	HI	6.7474	0.803E 01	1
38.3	RS	1.9957	0.142E 01	80.3	FS	6.1355	-0.288E 01	1
38.7	HI	2.3516	0.749E 00	85.4	EF	2.4247	0.000E 00	1
40.6	FS	1.5496	-0.900E 00	86.8	EP1	2.3758	0.193E 01	1
41.3	LO	1.1016	-0.428E 00	86.8	EP2	0.0109	0.739E 00	1
42.1	RS	1.8078	0.126E 01	87.5	SR	2.2692	-0.134E 00	1
42.7	HI	2.3736	0.683E 00	88.3	RS	4.3177	0.546E 01	1
43.6	FS	1.8496	-0.884E 00	88.5	HI	5.0555	0.466E 01	1
45.6	LO	1.1277	-0.140E 00	88.7	FS	3.8898	-0.599E 01	1
46.5	RS	2.1138	0.166E 01	89.3	LO	1.8095	-0.249E 01	1
46.9	HI	2.5137	0.900E 00	89.6	RS	3.8359	0.791E 01	1
47.8	FS	1.8759	-0.859E 00	89.9	HI	5.4999	0.791E 01	1
49.6	LO	1.0898	-0.247E-01	90.1	FS	4.1057	-0.675E 01	1
50.5	RS	1.9435	0.135E 01	90.6	LO	2.0517	-0.345E 01	1
50.9	HI	2.3599	0.101E 01	91.1	RS	4.5237	0.697E 01	1
51.9	FS	1.6815	-0.911E 00	91.3	HI	5.5499	0.604E 01	1
53.0	LO	1.1717	-0.365E 00	91.6	FS	3.8217	-0.677E 01	1
53.8	RS	1.9155	0.134E 01	92.0	LO	2.0237	-0.413E 01	1
54.2	HI	2.3055	0.869E 00	92.3	RS	3.9019	0.819E 01	1
55.0	FS	1.7699	-0.100E 01	92.7	HI	5.9437	0.458E 01	1
56.2	LO	1.1519	-0.335E 00	93.0	FS	4.3056	-0.580E 01	1
56.9	RS	1.8479	0.128E 01	93.5	LO	2.2418	-0.325E 01	1
57.5	HI	2.2857	0.469E 00	93.8	RS	3.6799	0.530E 01	1
58.1	FS	1.7858	-0.104E 01	94.1	HI	4.3715	0.240E 01	1
59.4	LO	1.1958	-0.153E 00	94.4	FS	3.5355	-0.329E 01	1
59.9	RS	1.5815	0.117E 01	95.1	LO	2.0275	-0.119E 01	1
60.7	HI	2.2237	0.815E 00	95.5	RS	3.2839	0.470E 01	1
61.3	FS	1.8897	-0.969E 00	95.8	HI	4.1199	0.293E 01	1
63.0	LO	1.1058	-0.129E 00	96.0	FS	3.3157	-0.393E 01	1
63.9	RS	1.9358	0.136E 01	96.6	LO	2.1478	-0.140E 01	1
64.3	HI	2.2918	0.736E 00	97.0	RS	3.6695	0.473E 01	1
65.1	FS	1.7957	-0.925E 00	97.2	HI	4.3919	0.411E 01	1
66.8	LO	1.1239	-0.247E-01	97.5	FS	3.5179	-0.411E 01	1
67.6	RS	1.8655	0.139E 01	98.2	LO	2.1819	-0.102E 01	1
68.1	HI	2.3598	0.791E 00	98.8	RS	3.8475	0.340E 01	1
69.0	FS	1.8056	-0.876E 00	99.0	HI	4.4056	0.311E 01	1
70.5	LO	1.1656	-0.170E 00	99.3	FS	3.6678	-0.354E 01	1
71.7	RS	1.9039	0.129E 01	100.1	LO	2.0737	-0.994E 00	1
72.2	HI	2.3198	0.601E 00	100.4	RS	2.8999	0.342E 01	1
72.9	FS	1.9418	-0.845E 00	100.9	HI	4.3375	0.269E 01	1

TABLE 1 Continued

NO.PI FOUND WAS 2618 NO.PI STORED WAS 2618

TYPE	AMPLITUDE	SUM,SMSQ,SLOPE	TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE
0	1.1854	-0.225E 00	101.2	FS	3.4816	-0.332E 01
S	3.0317	0.289E 01	101.9	LO	2.0578	-0.131E 01
S	3.4959	0.266E 01	102.4	RS	3.3196	0.358E 01
S	2.7757	-0.272E 01	102.7	HI	4.2155	0.306E 01
0	1.6578	-0.255E 00	103.1	FS	3.3295	-0.327E 01
S	5.0456	0.479E 01	103.7	LO	2.0874	-0.153E 01
S	5.6438	0.405E 01	104.2	RS	3.1718	0.307E 01
S	5.1478	-0.336E 01	104.6	HI	4.0337	0.189E 01
0	4.6935	-0.336E 01	104.9	FS	3.1537	-0.513E 01
S	6.5156	0.803E 01	105.5	LO	2.0858	-0.105E 01
S	6.7474	0.803E 01	105.9	RS	2.9779	0.329E 01
S	6.1355	-0.288E 01	106.4	HI	4.0139	0.154E 01
E	2.4247	0.000E 00	106.7	FS	3.1355	-0.321E 01
P	2.3756	0.193E 01	107.2	LO	2.1759	-0.145E 01
1	0.0109	0.739E 00	107.6	RS	3.0757	0.315E 01
2	2.2692	-0.134E 00	107.9	HI	3.7975	0.245E 01
P	4.3177	0.546E 01	108.2	FS	3.0954	-0.286E 01
S	5.0555	0.466E 01	108.8	LO	1.9979	-0.128E 01
S	3.8896	-0.599E 01	109.3	RS	2.8779	0.274E 01
S	1.8095	-0.249E 01	109.9	HI	4.2897	0.274E 01
S	3.8359	0.791E 01	110.4	FS	3.3937	-0.242E 01
S	5.4999	0.791E 01	111.2	LO	1.9836	-0.136E 01
S	4.1057	-0.675E 01	112.0	RS	3.7134	0.270E 01
S	2.0517	-0.345E 01	112.4	HI	4.4259	0.158E 01
S	4.5237	0.697E 01	112.8	FS	3.3196	-0.337E 01
S	5.5499	0.604E 01	113.5	LO	2.0918	-0.100E 01
S	3.8217	-0.677E 01	114.1	RS	3.2679	0.328E 01
S	2.0237	-0.413E 01	114.5	HI	4.4079	0.286E 01
S	3.9019	0.819E 01	114.9	FS	3.4157	-0.326E 01
S	5.9437	0.458E 01	115.9	LO	1.9276	-0.422E 00
S	4.3056	-0.580E 01	116.6	RS	3.5519	0.322E 01
S	2.2418	-0.325E 01	116.9	HI	4.1996	0.221E 01
S	3.6799	0.530E 01	117.2	FS	3.3816	-0.373E 01
S	4.3715	0.240E 01	117.9	LO	2.1715	-0.785E 00
S	3.5355	-0.329E 01	118.5	RS	3.1158	0.293E 01
S	2.0275	-0.119E 01	118.8	HI	3.8195	0.246E 01
S	3.2839	0.470E 01	119.1	FS	2.9938	-0.313E 01
S	4.1199	0.293E 01	119.9	LO	2.0874	-0.313E 01
S	3.3157	-0.393E 01	120.5	RS	3.4256	0.341E 01
S	2.1478	-0.140E 01	120.9	HI	4.3435	0.196E 01
S	3.6695	0.473E 01	121.3	FS	3.4239	-0.302E 01
S	4.3919	0.411E 01	122.2	LO	2.0654	-0.595E 00
S	3.5179	-0.411E 01	122.6	RS	3.1658	0.352E 01
S	2.1819	-0.102E 01	123.0	HI	4.2139	0.253E 01
S	3.8475	0.340E 01	123.3	FS	3.1674	-0.379E 01
S	4.4056	0.311E 01	124.1	LO	2.0874	-0.417E 00
S	3.6678	-0.354E 01	124.6	RS	3.4855	0.408E 01
S	2.0737	-0.994E 00	124.9	HI	4.2496	0.275E 01
S	2.8999	0.342E 01	125.1	FS	3.4558	-0.407E 01
S	4.3375	0.269E 01	125.9	LO	2.1539	-0.494E 00

TABLE 1 Concluded

VARIABLE NO. 2 NO.PI FOUND WAS 2541 NO.PI

TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE	TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE	
26.8	EP1	56.6199	0.000E 00	73.2	HI	66.5547	0.000E 00	1
27.1	RS	65.8223	0.256E 02	74.6	FS	62.4347	-0.162E 02	1
27.3	HI	63.3899	0.610E 00	76.2	LO	59.8040	0.000E 00	1
28.0	FS	61.5375	-0.266E 02	76.5	RS	68.9230	0.411E 02	1
29.6	LO	54.3839	-0.266E 02	77.1	HI	73.1894	0.427E 00	1
31.2	RS	65.1631	0.219E 02	78.3	FS	63.8081	-0.216E 02	1
31.8	HI	65.6270	0.183E 00	78.9	LO	59.4195	-0.305E 00	1
33.2	FS	55.9282	-0.227E 02	79.2	RS	74.8802	0.664E 02	1
34.1	LO	51.5762	-0.122E 00	80.3	HI	84.2982	0.305E 00	1
35.4	RS	66.9311	0.335E 02	81.8	FS	64.8457	-0.113E 03	1
35.9	HI	65.5903	0.000E 00	82.5	LO	47.4257	-0.366E 00	1
36.2	FS	63.4540	-0.170E 02	82.9	RS	67.0369	0.686E 02	1
37.2	LO	54.8783	-0.244E 00	83.4	HI	68.2943	0.000E 00	1
39.0	RS	63.4723	0.272E 02	83.8	FS	62.1723	-0.394E 02	1
39.6	HI	65.8955	0.272E 02	84.1	EF	55.7451	0.000E 00	1
40.3	FS	53.1550	-0.173E 02	86.8	EP1	56.1906	0.608E 02	1
42.2	LO	54.9699	-0.244E 00	86.8	EP2	0.0000	0.391E 02	1
43.5	RS	62.3004	0.219E 02	88.7	BA	57.5640	-0.122E 00	1
43.8	HI	64.0827	0.366E 00	89.0	RS	68.9230	0.496E 02	1
44.5	FS	59.7552	-0.335E 02	89.4	HI	73.4580	0.244E 00	1
46.4	LO	52.8153	0.000E 00	89.8	FS	71.5964	-0.885E 01	1
47.7	RS	68.6300	0.275E 02	90.3	LO	70.3390	0.000E 00	1
48.1	HI	69.2587	0.000E 00	90.6	RS	77.1935	0.296E 02	1
47.6	FS	63.0573	-0.283E 02	90.9	HI	80.0500	0.549E 00	1
50.4	LO	55.6657	0.000E 00	91.4	FS	76.7479	-0.126E 02	1
51.7	RS	63.3381	0.236E 02	91.8	LO	75.5882	0.000E 00	1
52.1	HI	65.2668	0.000E 00	92.2	RS	79.5739	0.145E 02	1
52.7	FS	58.9078	-0.308E 02	92.4	HI	80.1599	0.305E 00	1
53.6	LO	55.1469	0.000E 00	95.5	FS	65.7490	-0.452E 02	1
54.8	RS	61.6473	0.249E 02	96.1	LO	59.2425	-0.427E 00	1
55.1	HI	64.0156	0.183E 00	96.4	RS	68.2149	0.408E 02	1
55.8	FS	59.7003	-0.234E 02	96.9	HI	72.5058	0.427E 00	1
57.6	LO	54.4084	-0.122E 00	97.3	FS	67.2811	-0.250E 02	1
58.0	RS	61.8854	0.266E 02	97.9	LO	64.0156	0.000E 00	1
58.6	HI	62.6300	0.000E 00	98.3	RS	68.2760	0.137E 02	1
60.0	FS	56.7888	-0.140E 02	98.5	HI	68.5262	0.000E 00	1
60.7	LO	54.8783	-0.244E 00	99.1	FS	67.0369	-0.701E 01	1
61.1	RS	59.5477	0.166E 02	99.7	LO	66.1336	-0.366E 00	1
62.2	HI	61.3177	0.671E 00	100.0	RS	68.9046	0.116E 02	1
63.0	FS	59.5233	-0.909E 01	100.3	HI	69.8873	0.244E 00	1
62.8	LO	57.9973	-0.122E 00	100.8	FS	68.3553	-0.964E 01	1
65.0	RS	67.0186	0.253E 02	101.4	LO	66.5181	-0.183E 00	1
65.2	HI	68.0623	0.793E 00	101.8	RS	72.3288	0.195E 02	1
65.3	FS	63.2892	-0.231E 02	102.0	HI	72.8110	0.427E 00	1
67.5	LO	58.9405	0.000E 00	102.6	FS	69.3197	-0.153E 02	1
68.3	RS	66.4265	0.156E 02	103.1	LO	67.6778	-0.366E 00	1
69.2	HI	68.0990	0.000E 00	103.5	RS	73.7266	0.204E 02	1
70.2	FS	63.8946	-0.167E 02	104.0	HI	74.1599	0.183E 00	1
71.5	LO	56.8315	-0.244E 00	104.2	FS	72.0053	-0.142E 02	1
72.2	RS	65.7490	0.214E 02	104.8	LO	69.2831	-0.366E 00	1

TABLE 1 Concluded

.PI FOUND WAS 2541		NO.PI STORED WAS 2541			
PE AMPLITUDE	SUM,SMSQ,SLOPE	TIME	TYPE	AMPLITUDE	SUM,SMSQ,SLOPE
66.5547	0.000E 00	105.1	RS	72.9880	0.160E 02
62.4347	-0.162E 02	105.5	HI	74.6482	0.000E 00
59.8040	0.000E 00	105.9	FS	71.6147	-0.189E 02
68.9230	0.411E 02	106.5	LO	68.2577	0.000E 00
73.1894	0.427E 00	106.8	RS	71.8771	0.164E 02
63.8081	-0.216E 02	107.1	HI	73.6411	0.000E 00
59.4195	-0.305E 00	107.7	FS	70.4184	-0.117E 02
74.8802	0.664E 02	108.2	LO	69.6432	-0.183E 00
84.2982	0.305E 00	108.5	RS	73.9097	0.169E 02
64.8457	-0.113E 03	109.0	HI	75.0206	0.244E 00
47.4257	-0.366E 00	109.3	FS	71.6391	-0.168E 02
67.0369	0.686E 02	109.8	LO	69.2831	-0.366E 00
68.2943	0.000E 00	110.2	RS	73.2810	0.147E 02
62.1723	-0.394E 02	110.5	HI	74.1416	0.244E 00
55.7451	0.000E 00	111.8	FS	70.0705	-0.173E 02
56.1906	0.608E 02	112.3	LO	67.0369	-0.549E 00
0.0000	0.391E 02	112.7	RS	72.5913	0.235E 02
57.5640	-0.122E 00	113.1	HI	74.7642	0.000E 00
68.9230	0.496E 02	113.5	FS	71.4072	-0.195E 02
73.4580	0.244E 00	115.0	LO	66.5364	-0.183E 00
71.5964	-0.885E 01	115.3	RS	72.3715	0.246E 02
70.3390	0.000E 00	115.6	HI	74.5750	0.183E 00
77.1935	0.296E 02	116.1	FS	70.9189	-0.233E 02
80.0500	0.549E 00	116.7	LO	66.6097	-0.366E 00
76.7479	-0.126E 02	117.1	RS	70.1132	0.128E 02
75.5882	0.000E 00	117.6	HI	70.6076	0.000E 00
79.5739	0.145E 02	118.8	FS	65.8223	-0.128E 02
80.1599	0.305E 00	119.1	EF	63.6555	0.000E 00
65.7490	-0.462E 02	121.3	BR	64.2536	0.183E 00
59.2425	-0.427E 00	121.6	RS	72.8354	0.339E 02
68.2149	0.408E 02	122.1	HI	74.7154	0.244E 00
72.5058	0.427E 00	122.5	FS	67.3177	-0.565E 02
67.2811	-0.250E 02	123.2	LO	57.0024	-0.122E 00
64.0156	0.000E 00	123.5	RS	64.8823	0.355E 02
68.2760	0.137E 02	124.2	HI	68.5079	0.183E 00
68.5262	0.000E 00	124.5	FS	61.8182	-0.379E 02
67.0369	-0.701E 01	125.1	LO	56.2028	-0.122E 00
66.1336	-0.366E 00	125.5	RS	67.8487	0.441E 02
68.9046	0.116E 02	125.7	HI	69.3990	0.115E 01
69.8873	0.244E 00	126.4	FS	63.7592	-0.411E 02
68.3553	-0.964E 01	127.1	LO	56.2395	-0.183E 00
66.5181	-0.183E 00	127.4	RS	63.3564	0.330E 02
72.3288	0.195E 02	127.7	HI	67.1285	0.366E 00
72.5110	0.427E 00	128.4	FS	61.7084	-0.379E 02
69.3197	-0.153E 02	129.1	LO	54.9516	0.000E 00
67.6778	-0.366E 00	129.5	RS	61.5192	0.256E 02
73.7266	0.204E 02	129.7	HI	62.9902	0.976E 00
74.1599	0.183E 00	130.5	FS	58.4063	-0.242E 02
72.0053	-0.142E 02	131.3	LO	54.8295	-0.244E 00
69.2831	-0.366E 00	132.6	RS	63.6433	0.162E 02

VARIABLE - RESPIRATION

TABLE 2

SUMMARY OUTPUT FOR CLASSICAL CONDITIONING

REST 1	DUR	NO.	TC	NO.	MAG	NO.
INC	1.38	52.00	0.51	53.00	1.47	53.00
DEC	2.01	53.00	0.61	53.00	-1.49	53.00
	MEAN =	0.78	SDV =	0.52	NO. =	1800.00
OR TONE	DUR	NO.	TC	NO.	MAG	NO.
INC	1.39	1.00	0.54	2.00	1.30	2.00
DEC	1.50	2.00	0.54	2.00	-1.28	2.00
	MEAN =	0.72	SDV =	0.42	NO. =	57.99
OR PAIN	DUR	NO.	TC	NO.	MAG	NO.
INC	0.89	3.00	0.35	4.00	1.09	4.00
DEC	1.03	3.00	0.33	3.00	-0.93	3.00
	MEAN =	0.98	SDV =	0.42	NO. =	40.00
HI TONE	DUR	NO.	TC	NO.	MAG	NO.
INC	1.33	26.00	0.44	30.00	1.13	30.00
DEC	1.77	22.00	0.62	29.00	-1.13	27.00
	MEAN =	0.22	SDV =	0.69	NO. =	1170.01
PAIN	DUR	NO.	TC	NO.	MAG	NO.
INC	1.32	37.00	0.42	43.00	1.13	43.00
DEC	1.84	36.00	0.59	36.00	-1.11	38.00
	MEAN =	0.30	SDV =	0.66	NO. =	778.99

TABLE 2

OUTPUT FOR CLASSICAL CONDITIONING

NO.	MAG	NO.	SLOPE	NO.	DI/DC
53.00	1.47	53.00	1.62	53.00	0.406
53.00	-1.49	53.00	-1.35	53.00	
0.52	NO. =	1800.00			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
2.00	1.30	2.00	1.37	2.00	0.482
2.00	-1.28	2.00	-1.36	2.00	
0.42	NO. =	57.99			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
4.00	1.09	4.00	1.80	4.00	0.465
3.00	-0.93	3.00	-1.18	3.00	
0.42	NO. =	40.00			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
30.00	1.13	30.00	1.37	35.00	0.428
29.00	-1.13	27.00	-1.32	34.00	
0.69	NO. =	1170.01			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
43.00	1.13	43.00	1.34	43.00	0.417
36.00	-1.11	38.00	-1.27	38.00	
0.66	NO. =	778.99			

TABLE 2 Continued

VARIABLE = RESPIRATION

LO TONE	DUR	NO.	TC	NO.	MAG	NO.
INC	1.29	31.00	0.38	37.00	1.33	37.00
DEC	1.58	24.00	0.52	35.00	-1.19	26.00
	MEAN =	0.37	SDV =	1.03	NO. =	1158.99
NO PAIN	DUR	NO.	TC	NO.	MAG	NO.
INC	1.26	37.00	0.43	41.00	1.12	41.00
DEC	1.69	32.00	0.60	32.00	-1.00	35.00
	MEAN =	0.12	SDV =	0.68	NO. =	785.00
TEST 2	DUR	NO.	TC	NO.	MAG	NO.
INC	1.79	48.00	0.38	48.00	0.90	48.00
DEC	1.92	48.00	0.56	48.00	-0.90	48.00
	MEAN =	-0.45	SDV =	0.57	NO. =	1800.00

TABLE 2 Continued

NO.	MAG	NO.	SLOPE	NO.	DI/DC
37.00	1.33	37.00	1.70	39.00	0.446
35.00	-1.19	26.00	-1.71	37.00	
1.03	NO. =	1158.99			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
41.00	1.12	41.00	1.45	41.00	0.400
32.00	-1.00	35.00	-1.25	35.00	
0.68	NO. =	783.00			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
48.00	0.90	48.00	1.41	48.00	0.482
48.00	-0.90	48.00	-1.08	48.00	
0.57	NO. =	1368.00			

VARIABLE - HEART RATE

TABLE 2 Continued

TEST 1	DUR	NO.	TC	NO.	MAG	NO.
INC	0.95	48.00	0.39	48.00	4.34	48.00
DEC	2.07	39.00	0.78	40.00	-4.86	39.00
	MEAN =	60.13	SDV =	2.76	NO. =	1800.00

INCREMENT AS FIRST RESPONSE

OR TONE	DUR	NO.	TC	NO.	MAG	NO.
INC	0.50	1.00	0.19	1.00	2.89	1.00
DEC	2.50	1.00	1.80	1.00	-3.72	1.00

DECREMENT AS FIRST RESPONSE

OR TONE	DUR	NO.	TC	NO.	MAG	NO.
DEC	0.00	0.00	0.00	0.00	0.00	0.00
INC	0.00	0.00	0.00	0.00	0.00	0.00
	MEAN =	58.74	SDV =	1.18	NO. =	57.99

INCREMENT AS FIRST RESPONSE

OR PAIN	DUR	NO.	TC	NO.	MAG	NO.
INC	0.60	1.00	0.40	1.00	3.91	1.00
DEC	0.79	1.00	0.59	1.00	-2.64	1.00

DECREMENT AS FIRST RESPONSE

OR PAIN	DUR	NO.	TC	NO.	MAG	NO.
DEC	0.00	0.00	0.00	0.00	0.00	0.00
INC	0.00	0.00	0.00	0.00	0.00	0.00
	MEAN =	59.13	SDV =	1.47	NO. =	40.00

TABLE 2 Continued

	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
39	48.00	4.34	48.00	12.00	48.00		
78	40.00	-4.86	39.00	-11.02	40.00		
=	2.76	NO. =	1800.00				

	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
19	1.00	2.89	1.00	8.97	1.00	0.89	1.00
80	1.00	-3.72	1.00	-7.08	1.00		

	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
00	0.00	0.00	0.00	0.00	0.00		
=	1.18	NO. =	57.99				

	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
40	1.00	3.91	1.00	13.30	1.00	1.29	1.00
39	1.00	-2.64	1.00	-7.56	1.00		

	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
00	0.00	0.00	0.00	0.00	0.00		
	1.47	NO. =	40.00				

TABLE 2 Continued

VARIABLE - PEAK RATE

INC - PAT AS FIRST RESPONSE

MI TYPE	DUR	NO.	TC	NO.	MAG	NO.
INC	1.62	8.00	0.46	12.00	6.72	12.00
DEC	1.52	7.00	0.79	10.00	-4.93	7.00

DECREMENT AS FIRST RESPONSE

MI TYPE	DUR	NO.	TC	NO.	MAG	NO.
DEC	1.45	4.00	0.92	8.00	-4.02	8.00
INC	1.03	8.00	0.77	8.00	5.47	8.00
	MEAN =	61.95	SDV =	4.59	NO. =	1170.01

INCREMENT AS FIRST RESPONSE

PAIR	DUR	NO.	TC	NO.	MAG	NO.
INC	0.61	10.00	0.29	11.00	5.54	11.00
DEC	2.04	8.00	0.59	8.00	-5.40	8.00

DECREMENT AS FIRST RESPONSE

PAIR	DUR	NO.	TC	NO.	MAG	NO.
DEC	1.70	3.00	0.92	8.00	-6.43	8.00
INC	1.14	7.00	0.75	7.00	4.00	7.00
	MEAN =	60.27	SDV =	3.47	NO. =	778.99

INCREMENT AS FIRST RESPONSE

LO TYPE	DUR	NO.	TC	NO.	MAG	NO.
INC	0.58	8.00	0.29	12.00	5.74	13.00
DEC	1.43	6.00	0.61	7.00	-4.96	6.00

DECREMENT AS FIRST RESPONSE

LO TYPE	DUR	NO.	TC	NO.	MAG	NO.
DEC	1.19	4.00	0.92	7.00	-4.49	7.00
INC	0.84	4.00	0.90	6.00	3.65	4.00
	MEAN =	61.47	SDV =	5.08	NO. =	1158.99

TABLE 2 Continued

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
12.00	8.72	12.00	15.49	12.00	1.57	8.00
10.00	-4.93	7.00	-17.32	10.00		

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
8.00	-4.02	8.00	-10.66	8.00	0.64	4.00
8.00	5.47	6.00	14.00	8.00		

4.59 NO. = 1170.01

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
11.00	8.54	11.00	11.46	11.00	1.55	10.00
8.00	-5.40	8.00	-14.03	8.00		

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
8.00	-6.43	8.00	-18.73	8.00	1.40	3.00
7.00	4.00	7.00	10.82	7.00		

3.47 NO. = 774.99

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
12.00	5.74	13.00	15.27	13.00	1.63	9.00
7.00	-4.96	6.00	-12.76	7.00		

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
7.00	-4.49	7.00	-14.19	7.00	0.32	4.00
6.00	3.65	4.00	14.36	6.00		

5.08 NO. = 1158.99

VARIABLE - HEART RATE

TABLE 2 Continued

INCREMENT AS FIRST RESPONSE

NO PAIR	DUR	NO.	TC	NO.	MAG	NO.
INC	0.54	4.00	0.27	7.00	3.16	7.00
DEC	1.33	5.00	0.57	5.00	-6.36	5.00

DECREMENT AS FIRST RESPONSE

NO PAIR	DUR	NO.	TC	NO.	MAG	NO.
DEC	1.78	6.00	1.19	12.00	-6.14	12.00
INC	0.75	12.00	0.49	12.00	3.53	12.00
	MEAN =	61.82	SDV =	4.02	NO. =	785.00
REST 2	DUR	NO.	TC	NO.	MAG	NO.
INC	0.96	34.00	0.47	34.00	5.19	34.00
DEC	1.76	24.00	0.93	24.00	-6.22	24.00
	MEAN =	58.98	SDV =	4.36	NO. =	1800.00

TABLE 2 Continued

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
7.00	3.16	7.00	10.82	7.00	1.15	4.00
5.00	-6.36	5.00	-12.62	5.00		

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
12.00	-6.14	12.00	-15.15	12.00	0.44	6.00
12.00	3.53	12.00	10.60	12.00		
4.02	NO. =	785.00				

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
34.00	3.19	34.00	12.39	34.00		
24.00	-6.22	24.00	-14.47	24.00		
4.36	NO. =	1800.00				

TABLE 2 Continued

VARIABLE = USE

[illegible]	DUR	NO.	TC	NO.	MAG	NO.
INC	1.00	1.00	0.50	1.00	0.41	1.00
DEC	0.00	0.00	0.00	0.00	0.00	0.00
	MEAN =	7.22	SDV =	0.32	NO. =	1800.00
[illegible]	DUR	NO.	TC	NO.	MAG	NO.
INC	2.00	1.00	1.09	1.00	1.33	1.00
DEC	0.00	0.00	0.00	0.00	0.00	0.00
	MEAN =	7.44	SDV =	0.70	NO. =	57.99
[illegible]	DUR	NO.	TC	NO.	MAG	NO.
INC	11.00	1.00	10.20	1.00	8.53	1.00
DEC	6.20	1.00	3.39	1.00	-2.96	1.00
	MEAN =	8.76	SDV =	0.55	NO. =	40.00
[illegible]	DUR	NO.	TC	NO.	MAG	NO.
INC	2.06	8.00	1.15	8.00	2.64	20.00
DEC	0.00	0.00	1.29	1.00	0.00	0.00
	MEAN =	10.27	SDV =	1.87	NO. =	1170.01
[illegible]	DUR	NO.	TC	NO.	MAG	NO.
INC	3.26	9.00	2.04	11.00	2.76	20.00
DEC	3.63	17.00	1.89	17.00	-2.19	17.00
	MEAN =	12.40	SDV =	1.60	NO. =	778.99

TABLE 2 Continued

	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
50	1.00	0.41	1.00	0.65	1.00		
00	0.00	0.00	0.00	0.00	0.00		
	0.32	NO. =	1807.00				
	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
09	1.00	1.33	1.00	1.02	1.00	2.79	1.00
00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.70	NO. =	57.99				
	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
0	1.00	8.53	1.00	1.95	1.00	2.40	1.00
9	1.00	-2.96	1.00	-0.76	1.00	0.00	0.00
	0.55	NO. =	40.00				
	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
6	8.00	2.64	20.00	1.79	18.00	2.17	20.00
9	1.00	0.00	0.00	-0.82	1.00	0.00	0.00
	1.27	NO. =	1170.01				
	NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
4	11.00	2.76	20.00	1.61	11.00	2.05	9.00
9	17.00	-2.19	17.00	-0.90	17.00	6.36	9.00
	1.60	NO. =	778.99				

VARIABLE - GSR

TABLE 2 Concluded

LO TIME	DUR	NO.	TC	NO.	MAG	NO.
INC	2.06	17.00	1.18	17.00	1.88	20.00
DEC	0.00	0.00	0.00	0.00	0.00	0.00
	MEAN =	9.85	SDV =	1.58	NO. =	1156.99
LO PATH	DUR	NO.	TC	NO.	MAG	NO.
INC	2.75	4.00	1.85	4.00	2.70	5.00
DEC	2.90	2.00	1.95	2.00	-1.46	2.00
	MEAN =	10.47	SDV =	1.42	NO. =	785.00
TEST 2	DUR	NO.	TC	NO.	MAG	NO.
INC	2.03	6.00	0.81	6.00	1.20	6.00
DEC	0.79	1.00	0.19	1.00	-1.33	1.00
	MEAN =	9.22	SDV =	0.91	NO. =	1800.00

TABLE 2 Concluded

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
17.00	1.88	20.00	1.44	20.00	2.29	19.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.58	NO. =	1157.99				

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
4.00	2.70	5.00	2.01	4.00	6.17	4.00
2.00	-1.46	2.00	-0.84	2.00	0.00	0.00
1.42	NO. =	785.00				

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
6.00	1.20	6.00	1.09	6.00		
1.00	-1.33	1.00	-1.42	1.00		
0.91	NO. =	1800.00				

TABLE 3

SUMMARY OUTPUT FOR OPERANT CONDITIONING

VARIABLE - RESPIRATION

REST	DUR	NO.	TC	NO.	MAG	NO.
INC	1.66	316.00	0.49	323.00	0.63	323.00
DEC	1.63	324.00	0.55	329.00	-0.63	326.00
	MEAN =	1.87	SDV =	0.64	NO. =	11699.09
HI-RAISE	DUR	NO.	TC	NO.	MAG	NO.
INC	1.49	161.00	0.41	166.00	0.51	166.00
DEC	1.62	166.00	0.59	167.00	-0.52	167.00
	MEAN =	1.82	SDV =	0.47	NO. =	5377.99
LO-LOWER	DUR	NO.	TC	NO.	MAG	NO.
INC	1.57	142.00	0.47	144.00	0.39	144.00
DEC	1.59	141.00	0.55	144.00	-0.39	141.00
	MEAN =	1.85	SDV =	0.35	NO. =	5111.99

TABLE 3

OUTPUT FOR OPERANT CONDITIONING

NO.	MAG	NO.	SLOPE	NO.	DI/DC
323.00	0.63	323.00	0.83	337.00	0.505
329.00	-0.63	326.00	-0.78	331.00	
0.64	NO. =	11699.09			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
166.00	0.51	166.00	0.75	170.00	0.479
167.00	-0.52	167.00	-0.68	168.00	
0.47	NO. =	5377.99			
NO.	MAG	NO.	SLOPE	NO.	DI/DC
144.00	0.39	144.00	0.48	152.00	0.496
144.00	-0.39	141.00	-0.[illegible]	144.00	
0.35	NO. =	5111.99			

VARIABLE - HEART RATE

TABLE 3 Concluded

REST	DUR	NO.	TC	NO.	MAG	NO.
INC	1.48	314.00	0.75	635.00	19.15	321.00
DEC	1.99	306.00	0.99	623.00	-19.20	313.00
	MEAN =	90.58	SDV =	12.99	NO. =	11634.09
HI-RAISE	DUR	NO.	TC	NO.	MAG	NO.
INC	1.49	148.00	0.78	151.00	16.61	150.00
DEC	1.97	144.00	1.04	148.00	-16.80	146.00
	MEAN =	94.42	SDV =	10.22	NO. =	5377.99
LO-LOWER	DUR	NO.	TC	NO.	MAG	NO.
INC	1.34	150.00	0.67	150.00	18.11	150.00
DEC	1.94	145.00	0.95	149.00	-18.68	148.00
	MEAN =	85.88	SDV =	9.99	NO. =	5111.99

TABLE 3 Concluded

NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
635.00	19.15	321.00	44.22	323.00		
623.00	-19.20	313.00	-45.73	322.00		
12.99	NO. =	11634.09				
NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
151.00	16.61	150.00	38.97	152.00	0.00	0.00
148.00	-16.80	146.00	-38.60	148.00		
10.22	NO. =	5377.99				
NO.	MAG	NO.	SLOPE	NO.	LAT	NO.
150.00	18.11	150.00	43.45	150.00	0.00	0.00
149.00	-18.68	148.00	-44.43	151.00		
9.99	NO. =	5111.99				

TABLE 4

FACTOR LOADINGS FOR FA3B*

	Description***				Rotated Factor Loadings				
	Var-iable	(1)	(2)	(3)	1	2	3	4	5
1	173	HR	R1	MAG D	024	-236	-079	-961	008
2	174	HR	R1	MAG D N	-059	137	928	201	001
3	165	HR	R1	MAG I	-026	233	126	957	-009
4	166	HR	R1	MAG I N	-003	121	951	043	-030
5	790	SC	R1	MAG I N	161	851	055	189	-090
6	974	SP	R1	MAG D N	090	837	115	138	003
7	966	SP	R1	MAG I N	002	854	129	134	-183
8	825	SC	OR Tone	Standard Dev.	958	087	-065	-026	-155
9	848	SC	OR Pain	Standard Dev.	792	116	-029	-044	-340
10	1647	MT	PAIN	MAG** I	630	-101	005	005	-176
11	1637	SC	PAIN	MAG** I	530	117	006	016	-635
12	808	SC	OR Tone	MAG I	937	118	-106	-026	-195
13	831	SC	OR Pain	MAG I	492	070	057	-128	-440
14	847	SC	OR Pain	SUM	645	445	022	132	-004
15	887	SC	PAIN	MAG D	-358	-154	-036	-026	687

* All variables are from the classical conditioning session.

** These magnitude means were computed with absence of response in an epoch treated as a response of zero (0.0) magnitude.

*** (1) Physiological variable name; (2) epoch type from which measurement was taken; (3) parameter measured: MAG is mean response magnitude for an epoch type, SUM is mean level of the variable over all epochs of a type, D indicates decrement, I indicates increment, N indicates frequency of I or D.

TABLE 5 FACTOR LOADINGS FOR FA9B.

	VARIABLE	DESCRIPTION* (1)	(2)	(3)	(4)	1	2	3	4	ROTATED FACTOR LOADINGS 5	6	7
1	1401	OC	HR	SUM	HI-LO	258	-204	-037	206	-048	-235	-185
2	1461	OC	FP	D N	HI-LO	312	002	133	-318	087	070	229
3	1466	OC	FP	I N	R-LO	-175	210	005	-206	-051	079	126
4	1460	OC	FP	SUM	R-LO	-129	-014	-328	337	-396	-110	-110
5	1443	OC	SC	I N	HI-LO	925	039	-146	-012	032	-131	002
6	1479	OC	SC	D N	HI-LO	902	044	-127	045	-051	-259	036
7	1482	OC	SP	I N	HI-LO	879	-083	-147	005	015	-167	-110
8	1484	OC	SP	I N	R-LO	065	060	-086	-073	818	-063	-106
9	1487	OC	SP	D N	R-LO	-066	118	064	-007	836	-108	046
10	1448	OC	FP	SUM	R	031	981	-136	-076	058	-052	045
11	1452	OC	FP	SUM	HI	025	982	-134	-080	063	-047	050
12	1456	OC	FP	SUM	LO	035	981	-128	-084	068	-049	048
13	790	OC	SC	I N	R	109	159	-053	007	098	-914	105
14	809	OC	SC	I N	HI	533	088	-161	040	-193	-759	062
15	842	OC	SC	D N	LO	211	079	-075	056	-198	-861	116
16	966	OC	SP	I N	R	137	-015	-031	-094	262	-699	-129
17	977	OC	SP	SUM	R	-162	-126	968	073	098	024	016
18	998	OC	SP	SUM	HI	-176	-141	959	060	086	012	044
19	1037	OC	SP	SUM	LO	-150	-140	963	044	092	038	040
20	283	CC	HR	MAG D	HI TONE (CR)	045	159	-104	-017	-111	263	029
21	1517	CC	SP	MAG I	HI-LO TONE (Discr.)	-036	-006	-319	-066	-474	-003	061
22	1514	CC	SP	MAG D	HI-LO TONE (Discr.)	-033	-054	-279	-125	108	-055	171
23	1301	16PF-L			Suspiciousness	-036	110	-130	054	169	-169	438
24	1369	EPI-A			Motivation to succeed	-072	035	093	819	-024	025	077
25	1372	EPI-D			Plans work efficiently	081	-189	110	804	-025	049	001
26	1375	EPI-G			Articulate	118	-112	086	469	034	013	-088
27	1376	EPI-H			Feels Superior	-099	082	-047	-055	-102	060	657
28	1379	EPI-K			Self-Centered	028	099	046	090	-006	105	703
29	1381	EPI-M			Independence of Opinion	123	-093	086	-075	-190	-111	526
30	1382	EPI-N			Hard Worker	028	-077	004	779	047	060	027
31	1383	EPI-O			Neat in Dress	-102	054	-043	521	-078	-096	016

*(1) OC indicates operant and CC indicates classical conditioning; (2) Physiological variable name; (3) Parameter measured: MAG is mean response magnitude for epoch type, SUM is mean level of variable over all epochs of a type, D indicates decrement, I indicates increment, N indicates frequency of I or D. (4) HI, LO, and R indicate epoch types, singly; or in combination, e.g., HI minus LO.

TABLE 6

LO ACHIEVERS
(GROUP 1, N = 50)

	S NO.	RESIDUAL
1	1	-1.27
2	11	- .598
3	14	- .427
4	16	- .817
5	17	- .0794
6	18	- .8
7	29	- .157
8	32	- .0703
9	33	- .110
10	34	-1.34
11	35	-1.28
12	36	- .341
13	38	- .310
14	41	- .303
15	43	-1.25
16	45	- .364
17	49	- .195
18	51	-1.12
19	58	- .711
20	60	- .522
21	61	- .290
22	63	- .262
23	64	- .684
24	65	- .144
25	66	- .253
26	69	- .693
27	70	- .693
28	71	- .333
29	75	- .00787
30	77	- .816
31	79	- .101
32	80	-1.10
33	81	- .703
34	82	- .532
35	84	- .958
36	85	- .510
37	87	- .464
38	92	- .253
39	93	- .887
40	96	-1.10
41	97	- .424
42	98	-1.32
43	100	- .276
44	101	- .205
45	102	- .465
46	103	- .369
47	104	- .413
48	105	- .925
49	106	- .294
50	680	- .191

HIGH ACHIEVERS
(GROUP 2, N = 49)

	S NO.	RESIDUAL
1	2	.879
2	3	.586
3	4	.994
4	5	.814
5	6	.850
6	7	.956
7	8	1.41
8	9	.372
9	10	.914
10	12	.108
11	13	.0631
12	15	.0924
13	19	.462
14	20	.843
15	21	.381
16	22	.369
17	23	.288
18	24	.159
19	25	.308
20	26	.521
21	27	1.06
22	28	.504
23	30	.117
24	31	.0817
25	42	.530
26	44	.558
27	46	1.01
28	47	.516
29	48	.329
30	50	1.46
31	52	.365
32	53	.248
33	54	1.44
34	55	.508
35	56	.874
36	57	.910
37	59	.536
38	62	.431
39	72	.355
40	73	.245
41	76	.715
42	78	.482
43	83	.351
44	88	.475
45	90	.0676
46	91	.113
47	94	.308
48	95	.736
49	99	.0381

TABLE 7

LOW GRADE POINT AVERAGE
(GROUP 1, N = 50)

S NO.	GPA	S NO.	GPA
1	0.900	65	1.263
11	1.250	69	0.750
14	1.421	70	0.750
16	0.700	71	1.000
18	1.600	72	1.615
22	1.666	75	1.105
24	1.714	77	0.333
25	1.642	80	1.333
29	1.250	81	1.071
31	1.636	82	1.500
32	1.300	84	1.111
33	1.333	85	0.933
34	0.428	87	1.200
35	0.381	93	1.071
38	0.913	96	0.526
41	1.545	97	1.461
43	0.777	98	0.777
45	1.300	99	1.666
49	1.285	100	1.388
51	0.170	102	0.500
58	0.916	103	1.111
60	1.363	104	0.846
61	0.933	105	1.291
63	1.181	106	1.333
64	1.090	680	1.142

HIGH GRADE POINT AVERAGE
(GROUP 2, N = 49)

S NO.	GPA	S NO.	GPA
2	3.500	47	2.733
3	2.692	48	2.619
4	3.100	50	2.727
5	2.700	52	2.214
6	2.625	53	2.318
7	3.062	54	3.625
8	2.714	55	2.136
9	2.000	56	2.833
10	2.285	57	2.428
12	1.736	59	2.091
13	2.353	62	1.875
15	2.272	66	2.000
17	1.769	73	1.800
19	2.421	76	2.086
20	2.629	78	2.000
21	2.083	79	1.857
23	1.769		
26	2.444	83	2.200
27	2.583	88	2.545
28	2.500	90	2.100
30	2.076	91	3.167
36	1.875	92	2.000
42	2.636	94	2.083
44	2.444	95	2.438
46	2.789	101	1.937

TABLE 8

VARIABLES WITH SIGNIFICANT ACHIEVEMENT GROUP MEAN DIFFERENCES

VAR. NO.	VARIABLE NAME	LO	HI	t	PROB.
	PSYCHOLOGICAL VARIABLES				
1301	16PF-L Suspiciousness	4.23	3.47	2.065	.05
1369	EPI-A Motivation to succeed	17.30	20.22	2.670	.01
1372	EPI-D Plans work efficiently	18.88	22.50	2.508	.01
1375	EPI-G Articulate	10.16	11.93	1.788	.05*
1376	EPI-H Feels superior	11.62	9.93	2.194	.05
1379	EPI-K Self-centered	8.68	6.74	2.527	.01
1381	EPI-M Independent in opinion	5.26	4.56	1.804	.05
1382	EPI-N Is a hard worker	15.82	17.64	1.924	.05
1383	EPI-O Neat in dress	7.42	8.25	2.20	.05
1292	McClelland N-ACH	3.28	4.29	.884	NS**
1384	Object Sort Pathological Signs	2.17	2.67	1.299	NS**
FA5B-1	EPI Motivation A B C D E F I N	-.27	.27	2.681	.01
FA5B-4	EPI B-Status, C-Recog, F-Compet, K-Self Cent.	.17	-.17	2.327	.05
FA9B-4	EPI Motivation A D N O	-.30	.31	3.207	.01
FA9B-7	EPI H feels superior, M-Indep, 16PF-L Suspicious	.34	-.37	3.487	.01
	PHYSIOLOGICAL VARIABLES FROM C.C.				
283	HRD High Tone, CR+ (Dec Scored Neg.) C.C.	-8.63	-9.93	1.777	.05*
1514	SP-D1 H-L Tone Disc. C.C.	.07	-.45	2.160	.05
1517	SP-I1 H-L Tone Disc. C.C.	.19	1.41	1.701	.05*
FA1-3	Respiration Period (CR_+-CR_0) Disc. C.C.	-.22	.23	1.898	.05*
	PHYSIOLOGICAL VARIABLES FROM OP.C.				
435	FPI (Time Constant Rest)	2.18	2.47	2.488	.01
790	SC I N R	49.45	33.82	2.007	.05
798	SC D N R	28.76	13.21	2.385	.05
809	SC I N H	29.34	19.52	2.110	.05
819	SC D N H	19.39	8.73	2.532	.01
842	SC D N L	11.97	6.50	1.914	.05*
966	SP I N R	25.37	17.26	1.764	.05*
977	SP SUM R	-26.49	-21.21	1.998	.05*
998	SP SUM H	-26.96	-21.51	2.046	.05
1037	SP SUM L	-26.58	-21.15	2.061	.05
1448	FP SUM R	-367.89	-1039.27	2.902	.01
1452	FP SUM H	-372.34	-1047.34	2.919	.01
1443	SC I N H-L	.75	.29	2.140	.05
1456	FP SUM L	-360.56	-1041.89	2.947	.01
1460	FP SUM R-L	7.31	2.62	2.128	.05
1461	FP D N H-L	.18	-.07	2.353	.05

TABLE 8 (continued)

VAR. NO.	VARIABLE NAME	LO	HI	t	PROB.
	PHYSIOLOGICAL VARIABLES FROM OP.C.				
1466	FP I N R-L	.27	.04	2.080	.05
1479	SC D N H-L	.75	.20	2.514	.01
1482	SP I N H-L	.57	.28	1.757	.05*
1484	SP I N R-L	.10	-.10	1.988	.05
1487	SP D N R-L	.27	.01	2.228	.05
FA7B-1	SC N R,H,L	.17	-.17	1.819	.05*
FA7B-9	SP SUM R,H,L	-.28	.31	1.987	.05
FA8B-3	SC I N, D N; SP I N, D N R-L	.23	-.22	3.372	.01
FA9B-1	SC I N, D N; SP I N H-L	.21	-.20	2.176	.05
FA9B-3	SP SUM R,H,L	-.05	.06	2.840	.01
FA9B-5	SP I, D N R-L	.11	-.12	1.739	.05
1401	HR SUM H-L	1.84	2.74	1.658	NS**

*Starred variables are significant at the .05 null prob. level for a 1 tailed t-test

**These 3 variables were included to show the trend of the group differences although they were not statistically significant.

TABLE 9

VARIABLES WITH CORRELATIONS SIGNIFICANT WITH EITHER GPA OR ACH

Psychological Variables

No. of Var.	Name of Variable	GPA r	ACH r
	Achievement	.856	---
1368	Full WAIS I.Q.	.451	-.023*
1369	Edwards Personality Inventory (EPI) A. motiv. to succ.	.169*	.204
1372	EPI-D Plans Work Efficiently	.247	.262
1382	EPI-N Is a hard worker	.249	.234
1383	EPI-O Neat in dress	.152*	.197
FA9B-4	EPI - A D N O	.273	.312
1379	EPI-K Self-centered	-.308	-.222
1381	EPI-M Independent in opinion	-.286	-.162*
1302	16PF-M Imagination	-.161*	-.200
FA9B-7	EPI-H,K,M, 16PF-L Suspicious (H=feels superior)	-.311	-.246
1291	Locus of Control C + E	.215	---
1412	Awareness of contengency in C.C.	.228	---
	Physiological Variables from Classical Conditioning		
701	MT Mag I pain C.C.	-.195	---
808	SC Mag I O.R. to C.S. C.C.	-.210	---
877	SC Mag I Pain C.C.	-.225	---
FA3B-5	SC Low Mag I to pain	.217	.203
1514	SP Mag D. Disc.(CR_+-CR_0) (Dec Scored neg)	-.093*	-.203

(Table 9 continued on next sheet)

Table 9
(continued)

Physiological Variables from Operant Conditioning

No. of Var.	Name of Variable	GPA r	ACH r
1037	SP SUM R	.223	.223
998	SP SUM H	.233	.231
FA9B-3	SP SUM R, H, L	.204	.271
1448	FP SUM R	-.304	-.349
1452	FP SUM H	-.308	-.352
1456	FP SUM L	-.309	-.354
1460	FP SUM R - L (FP scored neg)	.277	.273
790	SC IN R	-.216	-.229
809	SC IN H	-.261	-.265
832	SC IN L	-.237	-.212
1443	SC Mag. I N H-L	-.220	-.259
1479	SC Mag. D N H-L	-.253	-.257
1482	SP Mag. I N H-L	-.195	-.172*
1487	SP Mag. D N R-L	-.166*	-.220
FA9B-1	SC + SP N H-L	-.222	-.207
1401	HR SUM H-L	.186*	.190*

** Achievement scores are residuals of GPA regressed on I.Q.
* Correlations starred are not significant but filled in for comparison. All other correlations in table are significant at least at the null probability of .05 or less with 2 tailed test.
- Indicates that particular correlation has not been computed.

TABLE 10

REGRESSION ANALYSIS FOR ACHIEVEMENT

Var Order	Var No.	Variable Name	CUM R^2	Δ R^2 PHYS	Δ R^2 PSY
1		ACH -- Dependent Variable			
2	1456	FP SUM L OPC	.1087	.1087	
3	1460	FP SUM R OPC	.1661	.0574	
4	809	SC IN H OPC	.2237	.0576	
5	FA9B-7	EPI-H,K,M; 16PF-L (Removed)	.2572		.0335
6	998	SP SUM H OPC	.2876	.0304	
7	1302	16PF-M Imaginative	.3086		.0210
8	FA9B-4	EPI-A, D, N, O MOTIV.	.3380		.0294
9	1487	SP D N R-L OPC	.3538	.0158	
10	1379	EPI-K Self-centered	.3630		.0092
11	FA9B-3	SP SUM R, H, L OPC	.3728	.0098	
12	790	SC N I R OPC	.3858	.0130	
13	1382	EPI-N Hard worker	.3959		.0101
14	FA3B-5	SC - Low Mag I, Pain OPC	.4044	.0085	
15	1383	EPI-O Neat in dress	.4100		.0056
16	1369	EPI-A Motivation to succeed	.4115		.0015
17	1443	SC Mag I N H-L OPC	.4128	.0013	
18	FA9B-1	SC + SP N H-L OPC	.4133	.0005	
19	1514	SP DI Hi-Low Tone cc (not used)			
20	1372	EPI-D Plans work efficiently (not used)			

Percent variance of ACH accounted for by OP Cond. Phys. Var. 30.3%

Percent variance of ACH accounted for by Psychol. Var. 11.0%

TABLE 11

REGRESSION ANALYSIS FOR GPA

Var Order	Var No.	Variable Name	CUM R^2	Δ R^2 PHYS	Δ R^2 PSY
1		G.P.A.			
2	1368	I.Q. Full WAIS	.2044		.2044
3	1456	FP SUM L OPC	.2790	.0746	
4	1460	FP SUM R-L OPC	.3316	.0526	
5	FA9B-7	EPI-H,K,M, 16PF-L (Removed)	.3847		.0531
6	1479	SC ND H-L OPC	.4192	.0345	
7	1382	EPI Hard worker	.4422		.0230
8	FA3B-5	SC Low mag to pain OPC	.4689	.0267	
9	998	SP SUM H OPC	.4837	.0148	
10	FA9B-3	SP SUM R,H,L OPC	.4892	.0055	
11	1379	EPI Self centered	.4968		.0076
12	1381	EPI Independence in opinion	.5033		.0065
13	832	SC NI L OPC	.5055	.0022	
14	790	SC NI R OPC	.5080	.0025	
15	809	SC NI H OPC	.5083	.0003	
16	1372	EPI Plans work efficiently	.5085		.0002
17	FA9B-4	EPI- A D N O Motivation	.5089		.0004
18	1443	SC NI H-L OPC (not used)			
19	1482	SP NI H-L OPC (not used)			
20	FA9B-1	SC + SP N H-L OPC (not used)			
				.2137	.2952

Psychological variables accounted for 29.52% of the variance in GPA of which 20.44% was I.Q. and 9.08% was EPI scales. Physiological variables accounted for 21.37% of the variance in GPA of which 18.70% was from Operant Conditioning and 2.67% was from Classical Conditioning variables.

TABLE 12

DISCRIMINANT FUNCTION ANALYSIS FOR ACHIEVEMENT

LOW ACHIEVEMENT GROUP			HIGH ACHIEVEMENT GROUP		
S-No.	L-GP PREDICTION	H-GP PREDICTION	S-No.	L-GP PREDICTION	H-GP PREDICTION
1	.371*	.628	1	.431	.568
2	.939	.060	2	.129	.870
3	.508	.491	3	.015	.984
4	.786	.213	4	.002	.997
5	.429*	.570	5	.368	.613
6	.466*	.533	6	.013	.968
7	.578	.421	7	.062	.937
8	.731	.268	8	.043	.956
9	.207*	.792	9	.212	.787
10	.727	.272	10	.543*	.456*
11	.991	.008	11	.190	.809
12	.556	.443	12	.161	.838
13	.765	.234	13	.433	.566
14	.824	.175	14	.053	.946
15	.802	.197	15	.145	.854
16	.852	.147	16	.158	.841
17	.425*	.574	17	.423	.576
18	.241*	.758	18	.228	.771
19	.766	.233	19	.387	.612
20	.388*	.611	20	.506	.493*
21	.682	.317	21	.046	.953
22	.255*	.744	22	.950	.049*
23	.983	.016	23	.413	.586
24	.649	.350	24	.640	.359*
25	.929	.070	25	.113	.886
26	.717	.282	26	.335	.664
27	.957	.042	27	.227	.772
28	.783	.216	28	.346	.653
29	.979	.020	29	.540	.459*
30	.929	.070	30	.011	.988
31	.977	.022	31	.089	.910
32	.910	.089	32	.184	.815
33	.759	.240	33	.012	.987
34	.767	.232	34	.475	.524
35	.925	.074	35	.758	.241*
36	.200*	.799	36	.327	.672
37	.586	.413	37	.121	.878
38	.708	.291	38	.388	.611
39	.685	.314	39	.470	.529
40	.812	.187	40	.449	.550
41	.976	.023	41	.152	.847
42	.765	.234	42	.343	.656
43	.761	.238	43	.284	.715
44	.685	.314	44	.473	.526
45	.741	.258	45	.450	.549
46	.875	.124	46	.503	.496*
47	.504	.495	47	.694	.305*
48	.589	.410	48	.792	.207*
49	.826	.173	49	.207*	.850
50	.783	.216			
	41 of Low GP Correct			40 of High GP Correct	

81 Subjects Correctly Predicted as to Achievement Group is 82.4% correct by the 19 variables supplied to the Regression Analysis.

TABLE #13
DISCRIMINANT FUNCTION ANALYSIS FOR GPA

LOW GPA GROUP S-No.	LOW GP PREDICTION	HIGH GPA GROUP S-No.	HIGH GP PREDICTION
1	.132*	1	.961
2	.924	2	.984
3	.605	3	.992
4	.590	4	.711
5	.192*	5	.917
6	.791	6	.986
7	.911	7	.941
8	.738	8	.666
9	.996	9	.667
10	.936	10	.761
11	.520	11	.718
12	.546	12	.704
13	.992	13	.913
14	.834	14	.981
15	.942	15	.886
16	.725	16	.848
17	.834	17	.307*
18	.636	18	.908
19	.425*	19	.036*
20	.831	20	.394*
21	.201*	21	.617
22	.925	22	.896
23	.638	23	.958
24	.942	24	.518
25	.669	25	.953
26	.648	26	.945
27	.900	27	.736
28	.799	28	.898
29	.893	29	.975
30	.994	30	.912
31	.936	31	.991
32	.140*	32	.789
33	.713	33	.567
34	.437*	34	.511
35	.941	35	.544
36	.559	36	.597
37	.782	37	.651
38	.558	38	.400*
39	.913	39	.196*
40	.907	40	.659
41	.343*	41	.569
42	.827	42	.856
43	.729	43	.708
44	.971	44	.900
45	.963	45	.824
46	.850	46	.716
47	.659	47	.395*
48	.956	48	.118*
49	.938	49	.857
50	.381*		

42 of low GPA GP correct. 42 of High GPA GP Correct.
84 subjects of 99 were correctly predicted as to GPA GP by the 19 variables supplied to regression analysis. 84.34% correct.

APPROVAL FOR RESEARCH BY LAFAYETTE CLINIC COMMITTEE ON HUMAN AND ANIMAL EXPERIMENTATION

TO WHOM IT MAY CONCERN:

The experimental procedure(s) involving human subject(s) outlined in this application, entitled "Autonomic Learning Aptitude as a Factor in Under-(achievement (and Motiva-(tion to (Achievement have been thoroughly evaluated and approved by the Committee on Human and Animal Experimentation of the Lafayette Clinic, following policies and procedures established by the Clinic entitled "Guidelines for Research Investigations Involving Human Subjects" (copy attached).

The Committee is composed of (number) members, who represent the following disciplines and interests: Mrs. Irene Okshea, Dr. Albert Ax, Dr. Charles Frohman, Dr. Alexander Lucas, Dr. Elliot D. Luby.

Albert J. Ax
Signature of Principal Investigator

Dr. Albert Ax
Name of Principal Investigator

Elliot D Luby
Signature of Chairman of Committee or his designate

Dr. Elliot D. Luby
Name of Chairman of Committee or his designate

Signature of Director of Lafayette Clinic or his designate

Dr. Jacques S. Gottlieb
Name of Director of Lafayette Clinic or his designate

Abraham Takahashi
Signature of Official authorized to sign for institution

Mr. Abraham Takahashi
Name of Official authorized to sign for institution

LETTER OF PERMISSION TO CONDUCT THIS STUDY BY THE
RESEARCH AND DEVELOPMENT DEPARTMENT OF THE DETROIT PUBLIC SCHOOLS.

SUBJECT: Approved Research Study — Research Study No. 69059

FROM : Robert S. Lankton, Divisional Director, Research and Development Dept.

TO : _____, Principal, _____School

DATE : May 2, 1969

The research study identified below has been reviewed and approved by the Research and Development Department in accordance with the statement of policy in the Administrative Handbook. Participation by individuals or by schools in this project is entirely voluntary.

If you desire further information, please call Dr. Ferdinand Galante of the Research Department, 833-7900, ext. 2302, Schools Center Building.

Name of research worker:

Dr. Albert F. Ax, Head, Psychophysiology Division, The Lafayette Clinic, 951 E. Lafayette, Detroit, Michigan 48207

Title of project:

Emotional Learning Aptitude and Achievement Motive in Underachievers

Purpose:

The Psychophysiology Laboratory at the Lafayette Clinic is continuing research into the problem of the underachiever and school dropout. Purpose of this study is to establish evidence for emotional learning aptitude and to relate it with the achievement motive and underachievement.

Grant-in-Aid from:

Office of Education, United States Public Health Service

Pupils and Schools involved:

About 100 pupils selected by principal and teachers for either under or normal achievement from one or two of the following schools: Cooley, Southeastern, Pershing, Northwestern, Northern, Martin Luther King Senior High.

Procedures:

1. The principals of these three high schools (Cooley, Southeastern, and Pershing) have already shown interest and have indicated tentative approval to participate in the study. Only one or two schools will be used.

2. Participation of pupils will be entirely voluntary. Each subject will be paid for his time (approximately $2.00 per hour). Students will be asked to report to Lafayette clinic for a series of tests including autonomic conditioning, fantasy tests of achievement motivation, level of aspiration, intelligence and personality tests. No drugs or blood samples will be used.

3. After agreement is obtained from students (70 underachievers and 30 normal achievers), their parents' permission, in written form, will

be required for students to participate. About six to eight hours of time will be required for the full battery of tests and this will necessitate the students' being excused from school for one day.

4. The subjects and the schools will be assured in writing that students' participation and the findings will be kept strictly confidential, nor will these findings be used for any other purpose than for scientific research publication. Anonymity of students and schools will be preserved.

5. About one year later, Dr. Ax and/or his staff will interview the subjects, which will require about one hour, to find out their employment or school status at that time.

6. Approximate starting date: October, 1969.

----------TEAR SHEET----------

SUBJECT: Research Study No. 69059

I am willing to cooperate with The Lafayette Clinic in the proposed study as outlined in this letter.

M. Montgomery

(Mrs.) M. Montgomery, Principal
Southeastern High School

5-9.

LETTER OF PERMISSION BY PARENTS FOR STUDENT TO PARTICIPATE

THE LAFAYETTE CLINIC

DETROIT

The Lafayette Clinic is making a study of healthy young people and adults. We have described this study to your child and asked if he would help the Clinic. When he comes to the Clinic he will be interviewed, given some standard tests of personality where body functions such as heart rate, sweating and so on will be measured by means of sensors on the skin. These measures include reactions to sound and to mild electrically produced heat sensation. No drugs or injections will be given and no blood samples will be taken. In any scientific publication of the results of this study, the identity of the participants will in all instances remain confidential.

Your cooperation is requested and your child will be paid for his participation in the study which will take about 6 hours. If you are willing to help in this way, please sign this slip at the bottom.

I am willing for my child to participate in this study at The Lafayette Clinic for the purpose described above. I have had an opportunity to fully discuss what he will be doing.

Parent_____ Child_____

Address_____

Witness_____ Date_____

LETTER OF PERMISSION BY STUDENT TO PARTICIPATE

THE LAFAYETTE CLINIC

DETROIT

The Lafayette Clinic is making a study of healthy young people and adults. We have described this study to you and asked if you would help the Clinic. When you come to the Clinic you will be interviewed, given some standard tests of personality where body functions such as heart rate, sweating and so on will be measured by means of sensors on the skin. These measures include reactions to sound and to mild electrically produced heat sensation. No drugs or injections will be given and no blood samples will be taken. In any scientific publication of the results of this study, the identity of the participants will in all instances remain confidential.

Your cooperation is requested and you will be paid for your participation in the study which will take about 6 hours. If you are willing to help in this way, please sign this slip at the bottom.

I am willing to participate in this study at The Lafayette Clinic for the purpose described above. I have had an opportunity to fully discuss what I will be doing.

Signed_____

Address_____

Witness_____ Date_____