HUFSTADER, RONALD ALAN. An Investigation of the Feasibility of Employing Scores on Tests of Musical Aptitude, Academic Achievement, Intelligence, and Selected Psychomotor Proficiencies as Prognosticators of Success in Beginning Instrumental Music. (1972) Directed by: Dr. Steven K. Hedden. Pp. 54.

It was the purpose of this study to investigate the possibility of using scores on tests of musical aptitude, academic achievement, intelligence, and selected psychomotor abilities as predictors of success in beginning instrumental music. The null hypothesis was that there would be no difference between the scores of successful and less successful beginning instrumental students on the above mentioned independent variables.

The subjects were thirty-four beginning instrumental music students. The two groups of subjects--highly successful and less successful--were selected from the instrumental programs in the Greensboro City Schools. Each of the students was given a musical aptitude test and selected psychomotor tests. Scores for the intelligence and academic achievement tests were taken from the permanent records of the students. The data were analyzed through the use of a discriminant function analysis.

It was found that the computed discriminant function equation was significant at the .05 level. The percentage of variability accounted for by using the discriminant function equation was found to be 37.2%. All the variables were found to make a unique contribution to the differentiation of groups; the more important variables seemed to be intelligence, musical aptitude, and academic achievement. Overall, 85% of the a priori group subjects were classified correctly by the use of the computed discriminant function equation.

After analyzing the data, the null hypothesis was rejected. It was

concluded that there is a difference between scores of successful and less successful beginning instrumental students on tests of musical aptitude, intelligence, academic achievement, and selected psychomotor tests.

AN INVESTIGATION OF THE FEASIBILITY OF EMPLOYING SCORES ON TESTS OF MUSICAL APTITUDE, ACADEMIC ACHIEVEMENT, INTELLIGENCE, AND SELECTED PSYCHOMOTOR PROFICIENCIES AS PROGNOSTICATORS OF SUCCESS IN BEGINNING INSTRUMENTAL MUSIC

by

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Approved by

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APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

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The author's family has contributed to the completion of this thesis in many intangible ways. His parents and brother have been a constant source of encouragement. His wife, Cathy, has provided assistance with many tasks and has been an inexhaustible source of strength.

R. A. H.

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CHAPTER I

INTRODUCTION AND PROBLEM

Introduction

According to much of the literature in the area of music education, there seems to be a growing interest in the evaluative and predictive possibilities of tests in music. Leonhard and House state that:

> Since 1918 educational measurement has undergone startling development, and tremendous strides have been made in the development and application of tests of many types. More recently educators have realized that adequate pupil appraisal involves more than the construction, administration, and scoring of valid and reliable measurement tools and that attention must be given to the formulation of instructional objectives, the definition of objectives in terms of pupil behavior, and the development of techniques to evaluate the behavioral outcomes.[1]

Nye and Nye feel that "Everyone concerned with the learning of music should be involved with evaluation."[2] According to Colwell,

> . . . much current discussion is concerned with evaluation programs in music education, but a "program" of evaluation is exactly what the profession has not had. A program implies that there is order, system, planning, and follow-up.[3]

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[1]Charles Leonhard and Robert W. House, Foundations and Principles of Music Education (New York: McGraw-Hill Book Company, 1959), p. 333.

[2]Robert E. Nye and Bernice T. Nye, Music in the Elementary School (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), p. 615.

[3]Richard Colwell, The Evaluation of Music Teaching and Learning (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), p. 25.

It seems that if one is to find an effective program of evaluation and prediction, tests need to be uncovered which can be used throughout the entire program of instruction. Evaluative and predictive processes need to be effective on the beginning level as well as the advanced level. It seems impossible, however, for one test to be effective in predicting success in all facets of music. In the Musical Aptitude Profile Manual, Gordon states that:

> . . . this test /MAP/, like any other aptitude test, cannot be considered a "perfect" instrument for predicting success in music. This is true because of a variety of other factors which contribute to musical success are not wholly accounted for in any test, including the Musical Aptitude Profile. Such factors as interest in and motivation for musical study, quality and quantity of formal music training, musical experience, opportunities to hear good music, parental encouragement of the study of music, cultural background, and physical coordination are also of considerable importance to success in musical endeavors.[4]

Gordon goes on to suggest that scores on the test should be used not to exclude students from a music program, but to give the instructor a greater knowledge of his students' strengths and weaknesses. He also contends that the teacher who has a knowledge of his students' scores on the MAP can do a better job with the students than the teacher who does not have the information. Aptitude tests, therefore, seem to be quite valuable for evaluative and predictive purposes.

It must be remembered, however, that "educators concerned with prediction of musical achievement generally agree that there are factors not

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[4]Edwin Gordon, Musical Aptitude Profile Manual (Boston, Massachusetts: Houghton Mifflin Co., 1965), p. 1.

measured by musical aptitude tests that do influence musical achievement."[5] Nye and Nye agree with Gordon and Young in that there are goals of instruction which must be evaluated other than those covered by musical aptitude tests. "Evaluation should be made in terms of the goals of instruction. . . . Cognitive, affective, and psycho-motor aspects of music learning must be evaluated."[6] It is interesting to note that the above sources consider physical aspects to be an important consideration for evaluative and predictive purposes. With this viewpoint, several studies were undertaken which attempted to find combinations of factors which would produce accurate and complete predictions of success in music.

Related Literature

The studies to be examined in this section will be concerned with the manner in which different variables correlate with some musical behavior, generally achievement in instrumental music. The variables will include personality and mental traits, psychomotor abilities, musical aptitude, intelligence, and academic achievement.

Sample and Hotchkiss undertook a study in which one goal:

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[5]William T. Young, "The Role of Musical Aptitude, Intelligence, and Achievement in Predicting the Musical Attainment of Elementary Instrumental Music Students," Journal of Research in Music Education, XIX (Winter, 1971), 385.

[6]Nye and Nye, op. cit., pp. 614-615.

> . . . was to determine whether certain personality characteristics and vocational interests could be associated with persistence in instrumental study; significant findings in this area could aid in predicting success in instrumental study.[7]

The subjects who participated in the study were all seventh grade students who had studied music for two years. The experimenters found that personality characteristics of band members were significantly different from those of non-band members. Band boys were found to be significantly higher than non-band boys in scientific and musical interests and on the intelligence and tender-mindedness scales as measured by the IPAT Junior-Senior High School Personality Questionnaire. Band girls were found to be significantly higher than non-band girls in musical interests and tendermindedness as measured by the same test.

Determining the relationship between specified personality and mental traits and ratings of musical abilities was the goal of a study by Cooley.[8] The subjects were undergraduate students at Michigan State University. The American Council on Education Psychological Examination, the Cooperative Reading Comprehension Tests, the Bernreuter Personality Inventory, and the Seashore Measures of Musical Talents were used by Cooley for evaluative purposes. The musical ability ratings of the subjects were supplied by members of the School of Music faculty. Cooley found that high intelligence, high reading ability, and high

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[7]Duane Sample and Sally M. Hotchkiss, "An Investigation of Relationships Between Personality Characteristics and Success in Instrumental Study," Journal of Research in Music Education, XIX (Fall, 1971), 307.

[8]John C. Cooley, "A Study of the Relationship Between Certain Mental and Personality Traits and Ratings of Musical Abilities," Journal of Research in Music Education, IX (Fall, 1961), 108-117.

scores on the musical aptitude test tend to accompany musicality. It also was found that there is a significant correlation between intelligence and reading ability rankings. Personality traits of the college music students were found to be different from those of the unselected college student, but there was no evidence that personality traits were correlated with musicality.

In his doctoral dissertation, McCoy[9] compared select psychomotor abilities of a group of undergraduate music majors with identical abilities of a group of undergraduate non-music majors. He found differences within the groups, but found no significant differences between the groups. It would seem quite logical that McCoy found differences within groups since:

> The two sexes appear to be quite similar in performance level and rate of growth up to the age of about 16 after which the females begin a fairly linear decline into the 70's. The males continue to improve to the age of 20, after which they, too, undergo a progressive impairment with advancing longevity.[10]

College undergraduate students generally range between the ages of seventeen and twenty-one. Consequently, many of the females would have reached their peak in psychomotor performance and started a slow, gradual decline. The males generally would be improving in their psychomotor performance abilities. Because they are nearing their peak, however, their improvement probably

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[9]Wesley L. McCoy, "A Comparison of Select Psychomotor Abilities of a Sample of Undergraduate Instrumental Music Majors and a Sample of Undergraduate Non-Music Majors" (unpublished Ph.D. dissertation, The Louisiana State University and Agricultural and Mechanical College, 1970).

[10]Clyde E. Noble, Blaine L. Baker, and Thomas A. Jones, "Age and Sex Parameters in Psychomotor Learning" in Readings in Motor Learning, ed. by Robert N. Singer (Philadelphia: Lea and Febiger, 1972), p. 206.

would be quite slow. Consequently, with the females gradually declining and the males gradually improving, it would seem quite logical that a difference would exist within groups. Since this same process is occurring in both groups, it also would seem quite logical that significant differences would not be found between groups.

If one were to experiment with a younger group, however, a greater difference might be found when comparing two groups. For example, an elementary age child is involved in a period of development in which physical growth seems to occur in sudden spurts.[11] Such might also be the case with psychomotor development. If this were true, psychomotor development might be important in attempting to predict success with instrumental music students.

Such was the case in a study undertaken by Cramer. In working with younger students, he found that "successful achievement in instrumental music performance at the fourth through the eighth grade levels was significantly influenced by the motor development of the individual student."[12] In addition, he found that "successful performance in instrumental music also was found to be accompanied by high standings in intelligence, pitch discrimination, rhythmic discrimination, tonal memory, and personal adjustment."[13]

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[11]Arnold Gesell, Child Development: An Introduction to the Study of Human Growth (New York: Harper and Brothers Publishers, 1949), p. 255.

[12]Erwin H. Schneider and Henry L. Cady, Evaluation and Synthesis of Research Studies Relating to Music Education (United States Office of Education, Report No. BR-5-0203-A, 1965), pp. 176-177.

[13]Schneider and Cady, op. cit., p. 177.

Young[14] used scores on the Musical Aptitude Profile, the Lorge-Thorndike Intelligence Test, and the Iowa Test of Basic Skills in an effort to predict success for elementary instrumental music students. He found that,

> . . . the identification of students most likely to succeed in music, as defined by the first category /skills such as aural perception of rhythms, melodies, and instrumental improvization/, is overall best facilitated by the use of one or more MAP scores in conjunction with either achievement or intelligence scores, depending upon the specific nature of the criterion. The identification of students most likely to succeed in music, as defined by the second category of achievement /intelligence abilities such as music reading and notation/, is best accomplished by the use of the ITBS /Iowa Test of Basic Skills/. The identification of students most likely to succeed in all musical achievement areas is accomplished most accurately through the use of a combination of all three tests.[15]

The multiple correlation coefficient was used to evaluate the composite combined predictive power of the test batteries. This coefficient was .72. Thus, the combined tests account for only 51.8% of the variance in ratings of achievement. Quite obviously, some other factor or factors is playing a large role in determining the success of instrumental students.

Gordon[16] used the Henmon-Nelson Test of Mental Ability, his Musical Aptitude Profile, and the Iowa Test of Basic Skills in attempting to predict success in music with elementary students. His study involved only twenty-eight students and therefore cannot be regarded as conclusive. Gordon did, however,

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[14]Young, op. cit.

[15]Young, op. cit., p. 395.

[16]Edwin Gordon, "A Study of the Efficacy of General Intelligence and Musical Aptitude Tests in Predicting Achievement in Music," Council for Research in Music Education, XIII (Spring, 1968), 40-45.

achieve a multiple predictive validity correlation coefficient of .84 by using all three tests as predictors. The combined tests in this case accounted for 70.6% of the variance in rating of achievement. This is a much more convincing figure than that reached by Young. In contrast to Young, however, Gordon has concluded that:

> . . . when musical aptitude scores /MAP/ are combined with just I.Q. scores or ITBS scores, the predictive coefficients are on the whole nearly the same (only slightly lower) than those found when all three test scores are combined. . . . It appears that over and above musical aptitude scores neither intelligence nor academic achievement test scores have much if anything at all to contribute to the accuracy with which success or achievement in instrumental music may be predicted.[17]

This conclusion seems somewhat unjustified, however, without further statistical calculation on the data. It seems that such a conclusion should not be drawn from simply examining the multiple predictive validity correlation coefficients. A better procedure would have been to subject the data to a discriminant function analysis. To hypothesize such a conclusion without this type of statistical treatment, however, seems to be quite misleading.

In the present section, each study seemed to demonstrate a correlation between the respective variables and achievement in music. The variables, however, never seemed to account completely for the success of a student in instrumental study. Consequently, it would seem to be an important contribution to the field of music education if a test, or battery of tests, could be found which would more completely account for success in instrumental music.

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[17]Gordon, op. cit., 44.

The Problem

In studying the literature, it seems that a combination of tests is more accurate in trying to predict success than a single test. It seems quite logical that a battery of tests consisting of a musical aptitude test, an intelligence test, an academic achievement test, and selected psychomotor tests might serve as an accurate predictor of probable success in instrumental music for beginning students.

Although these variables have been employed in previous studies in an attempt to predict success in instrumental music, they have not been used in the suggested combination. Gordon and Young both used an intelligence test, a musical aptitude test, and an academic achievement test in trying to predict success. Psychomotor tests were not used by either, however. Cramer found psychomotor development to be a significant factor in the prognostication of success with elementary students. Consequently, a combination of these four variables might prove to be quite accurate for the prediction of success in instrumental music for beginning students.

The null hypothesis which was tested was that there is no difference between the scores of successful and less successful beginning band students on tests of musical aptitude, intelligence, academic achievement, and selected psychomotor tests. In this study, successful students were those who were considered by their respective band directors to be in the top third of their band class. Less successful students were those who were considered by their respective band directors to be in the bottom third of their band class. It was

originally intended that the low group be comprised of instrumental drop-outs. Because of changes in the Greensboro City School System's pupil distribution procedure, this plan became impossible.

An attempt was made to answer the following questions concerning the problem:

1. Will the discriminant function analysis successfully differentiate between the score profiles[18] of successful and less successful students?
2. Does each variable make a unique contribution to the differentiation of groups?
3. Which variables seem to be more important in the differentiation of groups?

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[18] A student's scores on the seven variables will be designated as his score profile.

CHAPTER II

PROCEDURE

Procedure for Testing

So that the null hypothesis could be tested, four band directors in the Greensboro City School System were contacted concerning the study and all agreed to participate. Approximately seventy of their students were involved at the outset. The band directors were asked to divide their students as evenly as possible into three groups according to achievement. These groups were classified as high, middle, and low. In dividing their students into groups, the band directors were asked to consider such qualities as technique, tone quality, musical reading ability, rhythmic reading ability, and general musicianship. Appendix A contains a copy of the form used by the band directors.

Although using teacher rankings is a subjective method of dividing students into groups, it seems to be an accepted procedure. In fact, the validity of most standardized tests of musical "ability" has been established by computing the correlation of teacher rankings with scores on the test. For example, in the manual for A Test of Musicality, Gaston states that "The validity of this test rests upon the association between the teacher's evaluation of the musical personality of the pupil and that pupil's score on the test."[19] Since Gaston

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[19]E. Thayer Gaston, A Test of Musicality Manual (Lawrence, Kansas: Odell's Instrumental Service, 1957), p. 4.

concluded that ". . . the musicality test is a valid test and measures what it purports to measure, "[20] it would seem that teachers are capable of ranking students accurately.

Gordon, in the manual for the Musical Aptitude Profile, states that "Traditionally, estimates of concurrent validity of musical aptitude tests have been obtained through the process of correlating test scores with teacher ratings of students' musical talent."[21] He continues by stating that "Each of seven exceptionally well-qualified music teachers in a large school system who conducted performance groups rated the musical talent of their particular students."[22] Gordon concludes that the validity of the Musical Aptitude Profile, based on teacher ratings, is quite good.

In reporting on the Musical Aptitude Profile, Lehman states that,

> Validity coefficients for homogeneous groups, based upon teachers' ratings and composite test scores, classified by performance groups, range from .64 for elementary choir students to .97 for junior high boys' glee clubs, with a median of .79. These also are unusually high.[23]

Lehman concludes that "It /MAP/ is definitely one of the most important contributions to the continuing study of musical aptitude."[24] Consequently, Lehman

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[20]Gaston, op. cit., p. 5.

[21]Gordon, op. cit., p. 58.

[22]Ibid.

[23]Paul Lehman, Tests and Measurements in Music (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1968), p. 54.

[24]Ibid.

seems to approve of Gordon's manner of determining the validity of the test.

A further point which should be mentioned is that with the design being employed in this study, it was not necessary for the teacher to place each student in exactly the correct position. What was important was that the students were placed in the proper group: high, middle, and low. To further diminish any weakness inherent in using teacher rankings, only the top and bottom groups were used. This augmented the probabilities of attaining good separation between groups. Consequently, although there are some weaknesses in employing teacher rankings, the information above indicates that there is a strong precedent for using this method and the above-mentioned protective devices in the design are further aids in the alleviation of the problem.

The students were primarily fifth graders with a few fourth and sixth graders. All students were beginning instrumental students, however. Once the students had been divided into three groups, data were obtained from the high and low groups. The middle group, as mentioned earlier, was not used in the study so that two distinct groups of high and low achievers might be established. This decreased the number of participating students to forty-six. Of the forty-six students in these two groups, only thirty-four were included in the final study. The remaining twelve students were not used because of their absence on one or more of the testing days.

The students in the two selected groups took a battery of tests. This battery included Gaston's A Test of Musicality and a group of psychomotor tests. Several aptitude tests were considered for use in this study. "Musical aptitude

is usually defined as the potential or capacity for musical achievement."[25] Many musical tests have been developed to measure aptitude. Among those which are considered to be acceptable are the Wing Musical Intelligence Test,[26] the Bentley Measures of Musical Ability,[27] the Seashore Measures of Musical Talent,[28] the Gordon Musical Aptitude Profile,[29] and Gaston's A Test of Musicality.[30]

Gaston's test was chosen for use in the proposed study for several reasons. First, according to the A Test for Musicality Manual,[31] the validity of the test for grades 4-6 is quite good. Second, the reliability of the test for grades 4-6 also is quite high. Third, the test requires only twenty-five minutes to administer which gives it a decided advantage, considering an elementary student's concentration span.

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[25]Ibid., p. 8.

[26]Herbert D. Wing, Musical Intelligence Tests (Buckinghamshire, England: National Foundation for Educational Research /England and Wales/, 1961).

[27]Arnold Bentley, Measures of Musical Ability (New York: October House, Inc., 1966).

[28]Carl E. Seashore, Don Lewis, and Joseph G. Saeveit, Measures of Musical Talent (New York: The Psychological Corporation, 1960).

[29]Edwin Gordon, Musical Aptitude Profile (Boston, Massachusetts: Houghton Mifflin Co., 1965).

[30]E. Thayer Gaston, A Test of Musicality (Lawrence, Kansas: Odell's Instrumental Service, 1957).

[31]E. Thayer Gaston, A Test of Musicality Manual (Lawrence, Kansas: Odell's Instrumental Service, 1957).

Because of the study by Cramer, it was decided that psychomotor tests should be included as a part of the predictive battery of tests. Several different instruments were used to administer the psychomotor tests: a rotary pursuit apparatus, a visual choice reaction timer, a tachistoscope, and a tapping board. These tests were selected after conferring with an expert in the field of the physiology of exercise. The expert suggested that the skills measured by these tests would have some relationship to the skills used in instrumental music.

The rotary pursuit apparatus was used to evaluate eye-hand coordination of the students; this is a necessary skill in instrumental music. This apparatus consists of a metal box with a translucent top. Inside the box is an arm with a small light bulb attached to the tip. The light bulb faces toward the top of the box. The arm is centered in the box and attached to a small motor. This motor when started, rotates the arm in a continuous circle. The diameter of the circle can be regulated by sliding the light bulb to various positions on the arm. Once the arm has started rotating, the subject can see the light through the translucent top of the box. The subject holds a glass wand, which is attached to the box by a cord, in his hand and tries to keep the tip of the wand on the rotating light. An electric clock is attached to the rotary pursuit apparatus and tabulates the amount of time the subject has kept the tip of the glass wand in contact with the rotating light. The clock which was used measured from seconds to thousandths of a second. Each subject was given three trials, each of which lasted fifteen seconds. The amount of time registered on the clock was recorded for each trial for each subject. These three scores were summed to yield the subject's composite score

on the rotary pursuit apparatus.

The visual choice reaction timer was used to test the student's reaction time to a visual, nonverbal stimulus. The parallel with instrumental music performance should be clear: a successful musician must react quickly to visual, nonverbal stimuli. This instrument consists of two basic pieces of equipment. The first is used by the tester. This piece of equipment consists of a metal box with a dial with which one can select different lights and an initiation switch which will activate the appropriate light. Attached to the back of the box is a board which prohibits the subject from seeing which light has been selected. The other piece of equipment is for the subject. It consists of a metal box with a row of four lights on top. Each light is a different color. Directly in front of each light is a button which when depressed will turn off the light. An electric clock is attached to the tester's piece of equipment. The clock measures the amount of time which passes from the moment of activation of the light to the moment the subject depresses the proper button. Each subject was given two practice trials and five trials. The same sequence of lights was followed for each subject. A reaction time was recorded for each trial. The reaction times then were summed for a composite score for each subject.

A subject's accuracy and speed in recognizing numbers was evaluated by the use of a tachistoscope. The skill measured by this apparatus seems to be similar to the ability to read music. It was assumed that a student who could recognize several numbers, when the numbers are presented briefly, probably would be able to recognize quickly notes on a sheet of music. This instrument

also is a metal, boxlike object. In the front of the box there is a viewing screen through which cards, when illuminated, can be seen. A timer with settings which range from one second to one-fiftieth of a second also is located on the front. In addition, there is a switch which is depressed whenever the subject is ready to view the card. This switch activates a light which illuminates the screen and makes it possible to see the cards. On top and toward the back of the box is a slot in which the cards being used are placed. The cards which were used in the study have numbers arranged in the shape of an X. Figure 1 exemplifies the type of card which was used.

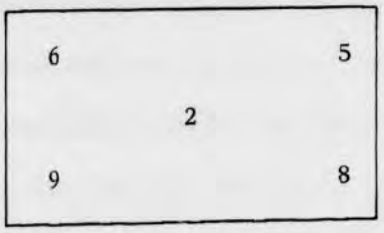

Fig. 1--Example of card used with tachistoscope

Cards of this type were used because of the similarities between the numbers on different levels and musical notes on a printed page. Musical notes were not used since it was not intended that musical achievement enter into this particular test. If a beginning instrumental student is for some reason not able to identify the names of musical notes on the different lines and spaces of the staff, he would not be able to obtain a high score on the test. Consequently, a source of possible invalidity would be introduced. Since beginning instrumental students are of an age when the identification of numbers is not difficult, numbers were used. Each student was given two practice trials and five trials. The cards

were illuminated for one-tenth of a second. The number of correct responses for each card was recorded and the scores for each card were summed for a composite score.

The tapping board was used to measure speed of hand movement. It was assumed that the skill measured by this apparatus seems to be similar to the speed of hand movement required in playing many of the musical instruments. This instrument consists of a board approximately sixteen inches long with a two inch metal square on each end. The subject holds a short metal rod with a plastic handle in his hand. Starting from the center of the board, the subject moves the rod back and forth between the metal squares, hitting a square each time. The subject was asked to accomplish this task as many times as is possible within a ten second interval. A mechanical counter, attached to the tapping board, recorded one count each time one of the metal plates was touched with the metal rod. Each student was asked to perform this task three times. A score was recorded for each trial and a composite score derived from the sum of the individual scores.

In addition to a score from Gaston's A Test of Musicality and composite scores from the battery of psychomotor tests, scores on intelligence and academic achievement tests were transcribed from each student's permanent record. The intelligence and academic achievement tests used by the Greensboro City Schools were respectively, the California Test of Mental Maturity[32] and the

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[32]Elizabeth Sullivan, Willis W. Clark, and Ernest W. Tiegs, California Test of Mental Maturity (Monterey, California: California Test Bureau, 1957).

California Achievement Test.[33] The permanent records were obtained from each student's respective school.

Procedure for Evaluation of the Data

To test the null hypothesis of the study, discriminant function analysis was employed. The band directors divided their students into three separate groups. As stated previously, only the top and bottom groups were used. These became the a priori groups in the discriminant analysis.

> Discriminant function analysis examines the score profiles . . . of subjects whose group membership already is known. It searches through the score profiles of the groups in an effort to determine whether it is possible to differentiate one group from another on their score profiles.[34]

In this type of analysis, an equation called a discriminant function is computed. This equation is a linear combination of the independent variables. The several variables each are assigned different weights in order to maximize differentiation between groups. A weight is assigned to a variable through a process which explores the scores of both a priori groups on that variable. Because the function is a linear combination, it collapses the independent variables into a single dimension. Thus, the groups will be plotted on a single line. If the groups are truly different, there will be little, if any, overlapping of distributions

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[33]Ernest W. Tiegs and Willis W. Clark, California Achievement Test (Monterey, California: California Test Bureau, 1957).

[34]Steven K. Hedden, "A Multivariate Investigation of Reaction Profiles in Music Listeners and Their Relationships with Various Autochthonous and Experiential Characteristics" (unpublished Ph.D. dissertation, The University of Kansas, 1971), p. 71.

along the single line. An illustration might provide some assistance at this point.

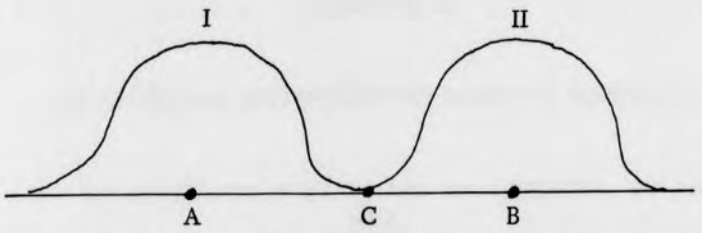

Fig. 2--Possible distribution on discriminant function

In this figure, A would clearly be a member of group I, while B would clearly be a member of group II. C, however, is plotted between the two groups. Therefore, C could not be assigned with great accuracy to either group.

The discriminant function computer program which was utilized in this study was BMD07M.[35] The variables are added one at a time in this program to determine the amount of effect each variable has on the ultimate differentiation of groups. This feature helps in assuring that the added variable does contribute to the differentiation of groups.

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[35]W. J. Dixon, BMD Biomedical Computer Programs (Berkeley: University of California Press, 1970), p. 214a.

CHAPTER III

EVALUATION AND INTERPRETATION OF THE DATA

Once the compilation of all the data was completed, each student's score profile was recorded on an IBM card; thus, one card contained all the scores obtained by a subject on the various tests. Appendix B contains the raw data for the thirty-four subjects used in the present study. The thirty-four data cards were combined with a second group of cards, the control cards. These control cards specified to the computer the manner in which the data cards were to be processed, and designated the program which was to be executed. As was mentioned in Chapter II, the BMD07M program was used for the computational procedure. The computer analyzed the data and returned a printout containing the requested information.

The first step in the evaluation of the data was to discover whether the computed discriminant function equation was significant. The discriminant function equation is an equation which contains the independent variables used, a weight for each variable, and a constant. The equation for this study was computed as follows, where Y is the subject's score on the discriminant function equation and X_{11} is the raw score of subject 1 on variable 1.

$$Y = -.987X_{11}+23.142X_{12}+1.694X_{13}-.024X_{14}+.784X_{15}+.871X_{16}$$
$$+18.029X_{17}-133.824$$

The determination of significance was achieved by using the following formula:

$$\underline{V} = 2.3026 \left(N-1-\frac{p+k}{2}\right) \log (1+\lambda)^{36}$$

N = number of subjects
k = number of groups
p = number of variables
λ = eigenvalue

The computed $\underline{V}$- value was 14.444. By reference to a chi square table, using seven degrees of freedom,[37] it was found that the equation was significant at the .05 level. Consequently, the probability of the computed equation's occurring by chance alone is less than five times out of one hundred. Since the equation was found to be significant, other interpretation of data was made.

The second statistic which was observed was the eigenvalue; this was found to be .66186. By using this value in an equation, it is possible to compute the percentage of variability accounted for by the discriminant function equation. This was accomplished by using the formula:

$$\underline{\omega}^2 = 1 - \frac{N}{(N-k)\ (1+\lambda)}$$ [38]

The value which resulted from this computation was .3724. Consequently, the discriminant function equation accounted for 37.2% of the differentiation between the successful and less successful groups of beginning instrumental students. Although this is not an extremely high percentage, it is an acceptable one. In

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[36]Maurice M. Tatsuoka, Discriminant Analysis: The Study of Group Differences, Selected Topics in Advanced Statistics: An Elementary Approach, No. 6 (Champaign, Illinois: The Institute for Personality and Ability Testing, 1970), p. 44.

[37]The degrees of freedom to be used were calculated by using the formula, df = p k-2.

[38]Tatsuoka, op. cit., p. 38.

using a discriminant function analysis, an accountability of fifty percent is considered a high percentage.[39] Therefore, the above percentage is quite acceptable.

The BMD07M program uses a step by step procedure, i.e., the variables are added one at a time; thus, if a variable does not make a unique contribution, it will not be added or will be withdrawn from the discriminant function equation. In the present study, all variables were added and none was withdrawn. Consequently, each variable was making a unique contribution to the separation of the groups.

Once all the variables have been entered (and withdrawn if needed), the program runs a check on its predictions concerning group membership. This is accomplished by classifying the subjects into groups according to their scores on the variables. This classification is compared with the original group membership, the a priori groups.

Fourteen of the eighteen a priori group A members could be classified as members of group A on the basis of their score profiles. The score profiles of four of the a priori group A members, however, more closely resembled the mean score profile of group B. After placing the score profiles of the a priori group B members into the discriminant function equation, fifteen of the original sixteen could be classified as members of group B. Only one member of the original group B was better classified as a member of group A. Consequently,

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[39]Hedden, op. cit., p. 94.

fourteen of the eighteen a priori members of group A, or 77%, could be classified correctly after substituting their score profiles in the discriminant function equation; fifteen of the sixteen a priori group B members, or 94%, could be classified correctly.

Judging by the percentages attained in the present study, group B members (less successful beginning instrumental students) could be classified more correctly as to group membership than could group A members (successful beginning instrumental students). Overall, 85% of the subjects were placed in the appropriate groups through the use of weighted scores on the different variables. Thus, the variables seem to serve as satisfactory predictors of success, or the lack of success, in beginning instrumental music for the subjects utilized in the present study. Stated alternatively, the program was able to achieve a high degree of "correctness of fit" between the a priori and the a posteriori groupings.

A further demonstration of the classification of subjects into groups is provided by the plot in Figure 3. This plot is a part of the printout provided by the BMD07M program. The reader should be concerned only with the horizontal axis of the plot in Figure 3; the vertical axis deals with an element of error and is not a concern of the present study. The farther to the left of the center of the plot (negative side) a subject is placed, the greater is the probability of that subject's being a member of, in this case, group A. Conversely, the farther to the right of the center of the plot (positive side) a subject is placed, the greater is the probability of that subject's being a member of group B. The asterisks on

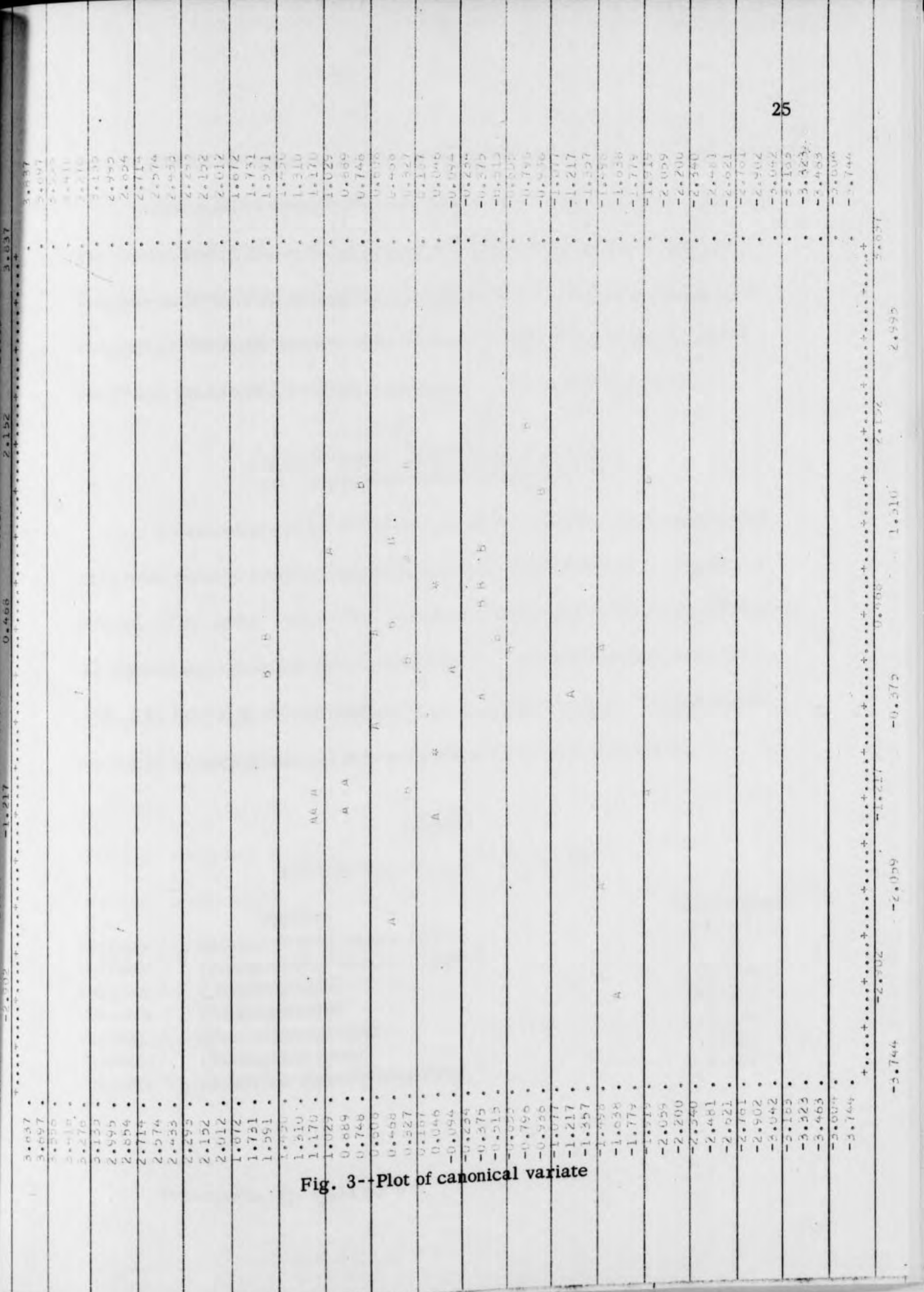

Fig. 3--Plot of canonical variate

the plot indicate the mean scores on the discriminant function of groups A and B.

The relative importance of each variable in the prediction of success was determined by calculating the scaled weights of the different variables. This was accomplished through the use of two sets of numbers: the diagonal elements of the within groups sums-of-squares-and-cross-products matrix (SSCP) and the canonical variate coefficients. The formula used was:

$$v_i^1 = \sqrt{w_{ii}} \cdot v_i^{40}$$

w_{ii} = diagonal element of SSCP matrix
w_i = canonical variate coefficient

To calculate the SSCP matrix, the elements of the covariance matrix were multiplied by 32 (N-k, where N = number of subjects and k = number of groups). The square root of each resultant number was found and multiplied by the appropriate canonical variate coefficient. The scaled weights were calculated by following this procedure for each of the variables. Table 1 shows the scaled weights of each of the variables used in the present study.

TABLE 1

SCALED WEIGHTS OF VARIABLES

Variable		Scaled Weight
Variable 1	(Rotary Pursuit Apparatus)	+1.796
Variable 2	(Visual Choice Reaction Timer)	- .567
Variable 3	(Tachistoscope)	- 1.194
Variable 4	(Tapping Board)	+2.365
Variable 5	(Test of Musicality)	- 3.348
Variable 6	(Intelligence Test)	- 3.554
Variable 7	(Academic Achievement Test)	- 3.274

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[40] Tatsuoka, op. cit., p. 52.

After having calculated the various scaled weights, the relative importance of variables was ascertained by ranking the absolute values of the scaled weights. As can be seen in Table 1, variable 6 had the largest scaled weight, -3.554. Next was variable 5 which had a scaled weight of -3.348. Table 2 shows the seven variables ranked in their order of importance.

TABLE 2

VARIABLES RANKED IN ORDER OF IMPORTANCE

Variable 6	(Intelligence Test)	- 3.554
Variable 5	(Test of Musicality)	- 3.348
Variable 7	(Academic Achievement Test)	- 3.274
Variable 4	(Tapping Board)	+2.365
Variable 1	(Rotary Pursuit Apparatus)	+1.796
Variable 3	(Tachistoscope)	- 1.194
Variable 2	(Visual Choice Reaction Timer)	- .567

The variables which seem to be of most importance to the prognostication of success must be decided upon simply by seeking a natural breaking point in the various scaled weights.[41] This, unfortunately, is a deficiency of the technique which has not been overcome. With this subjective method of selection, however, it seems that scores on the tests of intelligence, musical "ability," and academic achievement contributed the most to the prediction of success in this study. It must be remembered, however, that each variable was entered into the discriminant function equation and, consequently, each did contribute some unique factor to the predictive power of the test battery.

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[41]Tatsuoka, op. cit., pp. 53-54.

The variable with the largest scaled weight was variable 6 (intelligence) with a weight of -3.554. Because this is a negative weight, a subject scoring high on this variable will be placed far to the left (negative) side of the plot. It should be remembered that this is the side on which the vast majority of group A members (successful) were plotted. Consequently, the higher the score obtained by a subject on this variable, the farther to the left that subject will be placed. Conversely, the lower the score obtained by a subject, the farther to the right, or the side of the less successful group members, that subject will be placed.

Variable 5 (Test of Musicality) and variable 7 (academic achievement) were second and third respectively in order of importance. As can be observed in Table 2, both variables have negative scaled weights. Therefore, the principles mentioned above would apply also to the interpretation of these variables.

A positive scaled weight was computed for variable 4 (tapping board), the fourth variable in the order of importance. On this variable, a high score would place a subject on the right side of the plot, where group B members were located. Therefore, this variable has an inverse correlation; i.e., the successful subjects typically obtain a low score on this variable while the less successful subjects typically procure a high score. Consequently, a low score would be expected on this variable for a group A member and a high score would be expected for a group B member.

Because of the computed scaled weights, low scores would be expected from group A members on variable 1 (Rotary Pursuit Apparatus), and high scores

would be expected on variables 3 (Tachistoscope) and 2 (Visual Choice Reaction Timer). Conversely, high scores would be expected from group B members on variable 1, and low scores would be expected on variables 3 and 2.

Because all seven variables were entered and kept in the discriminant function equation, each variable made a unique contribution to the separation of groups. Therefore, all seven variables were important in the separation of groups achieved in the present study. The more important variables, however, seem to be intelligence, musical aptitude, and academic achievement. Because the psychomotor variables were entered and retained in the discriminant function equation, they did make a unique and significant contribution to the equation. This seems to indicate that a relationship between the psychomotor tests and success in instrumental music does exist.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

It appears that the field of music education recently has become quite interested in the evaluation and prediction of success. Many music educators have expressed a great concern for the lack of acceptable evaluative and predictive measures, and for the lack of research in this area.

Several articles have been written concerning these problems. Some sources seem to suggest that because musical aptitude tests do not seem to account completely for prediction of success in music, the relationship of other factors with success also should be measured. One factor which seems to be mentioned quite frequently is that of psychomotor development. Many educators seem to speculate that physical abilities might play an important role in predicting success in instrumental music.

Several studies have been completed which attempted to ascertain the relationship of items other than strictly musical ones with success in instrumental music. Such extra-musical variables as personality, intelligence, academic achievement, and psychomotor abilities have been shown to have significant relationships with musical ability. Sample and Hotchkiss found that personality characteristics of band members were significantly different from

those of non-band members.[42] Cooley found that high intelligence, high reading ability, and high scores on musical aptitude tend to accompany musicality.[43] Psychomotor development was found to influence significantly achievement in instrumental music performance at the fourth through the eighth grade levels in a study by Cramer.[44] Young found that scores on musical aptitude, intelligence, and academic achievement tests all contribute to the prediction of success for elementary instrumental music students.[45] Gordon undertook a study which also found that scores on tests of musical aptitude, intelligence, and academic achievement contribute to the prediction of success.[46] None of these studies, however, was able to account completely for success in instrumental music. In addition, none of the studies employed all the variables used in the present study.

The purpose of the present study was to attempt to find a test, or battery of tests, which would serve as an acceptable prognosticator of success for beginning instrumental music students. After reviewing the literature, it was decided that a battery of tests probably would serve as a better predictor than would a single test. It was decided that tests measuring musical aptitude, intelligence, academic achievement, and selected psychomotor abilities would be

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[42]Sample and Hotchkiss, op. cit.

[43]Cooley, op. cit.

[44]Scheider and Cady, op. cit.

[45]Young, op. cit.

[46]Gordon, "A Study of the Efficacy of General Intelligence and Musical Aptitude Tests in Predicting Achievement in Music."

used. Gaston's A Test of Musicality[47] was selected for use as the musical aptitude test. A rotary pursuit apparatus, a visual choice reaction timer, a tachistoscope, and a tapping board were used to measure the selected psychomotor abilities. The intelligence test (California Test of Mental Maturity)[48] and academic achievement test (California Achievement Test)[49] scores were taken from the students' permanent records.

Four band directors in the Greensboro City School System were contacted concerning participation in the study; all agreed to participate. Approximately seventy of their students were involved at the outset. The band directors were asked to divide their students into three groups of equal size according to achievement. The groups were designated as high, middle, and low. Only the high and low groups were used in the study so that a better separation of groups could be attained. Of the forty-six students in these two groups, only thirty-four were included in the final study. The remaining twelve students were not used because of absences on one or more of the testing days. Of the thirty-four students in the final study, eighteen were in the high (successful) group and sixteen were in the low (less successful) group. All of these students were given the complete battery of tests. A score profile was prepared for each student from his scores on the various tests.

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[47]Gaston, op. cit.

[48]Sullivan, Clark, and Tiegs, op. cit.

[49]Tiegs and Clark, op. cit.

The score profile of each student was recorded on an IBM card, and the BMD07M program was used for computational purposes. The computer analyzed the data and returned a printout containing the requested information.

The computed discriminant function equation was found to be significant at the .05 level. The percentage of variability accounted for by using the discriminant function equation was found to be 37.2%. All the variables were found to make some unique contribution to the differentiation of groups; the more important variables seemed to be intelligence, musical aptitude, and academic achievement. This rank of importance was determined by examination of scaled weights. It was found that 77% of the a priori group A members could be classified correctly on the basis of score profiles. Of the a priori group B members, 94% could be classified correctly on the basis of their score profiles. Overall, 85% of the subjects were classified correctly by the use of the computed discriminant function equation. This seems to demonstrate a rather high degree of accuracy in the overall predictive power of the battery of tests used in the present study. In addition, the predictive power of the battery for the less successful students seems to be greater than that for the successful students. The predictive power for both groups, however, seems to be quite good.

Because of the weights computed for the seven variables, group A members would be expected to obtain high scores on variable 2 (Visual Choice Reaction Timer), variable 3 (Tachistoscope), variable 5 (Test of Musicality), variable 6 (Intelligence), and variable 7 (Academic Achievement Test). Conversely, group B members would be expected to obtain low scores on these

variables. On variables 1 (Rotary Pursuit Apparatus) and 4 (Tapping Board), high scores would be expected from group B members while low scores would be expected from group A members.

Conclusions

The following statements will provide answers to the questions set forth at the end of Chapter I.

1. Will the discriminant function analysis successfully differentiate between the score profiles of successful and less successful students?

   Yes. It was found that the computed discriminant function equation was significant at the .05 level and that it seemed to differentiate successfully between the two groups. The percentage of variability accounted for by using the discriminant function equation was found to be 37.2%. Although this percentage seems to be rather low, an accountability of fifty percent is considered quite high in using a discriminant function analysis. Therefore, the above percentage is quite acceptable. The plot of canonical variates provided a visual depiction of the separation which could be made between the two groups. This separation was comparable to the example of good separation shown in Figure 2. It was also found that 85% of the students in the a priori groups could be classified correctly through the use of the computed discriminant function equation.

2. Does each variable make a unique contribution to the differentiation of groups?

   Yes. Because the BMD07M program is a stepwise procedure, each variable is added to the equation separately. If a variable is added to the equation and not withdrawn, it is making a unique contribution to the differentiation of groups. In the present study, all the variables were added and none was withdrawn. Consequently, each variable seems to make a unique contribution to the differentiation of groups.

3. Which variables seem to be more important in the differentiation of groups?

   By computing a scaled weight for each variable, the importance of a variable can be determined by observing the value of that weight. Although such a procedure is subjective, it is the only method which presently is available. In the present study, intelligence, musical aptitude, and academic achievement seemed to be the more important variables. The psychomotor variables, however, did contribute to the differentiation of groups. This was demonstrated by the fact that they were added to the discriminant function equation.

After analyzing the data, the null hypothesis, which stated that there is no difference between the scores of successful and less successful beginning instrumental students on tests of musical aptitude, intelligence, academic achievement, and selected psychomotor tests, was rejected. The data seemed to point

strongly toward the conclusion that there is a difference between scores of successful and less successful beginning instrumental students on the selected variables.

Recommendations for Future Research

1. The present investigation involved only thirty-four subjects in the final study. Because of the small number of subjects employed, the results of the study should be applied to a larger population only with caution. Consequently, a more definitive study involving a much larger number of subjects is needed.
2. It seems that future studies might be well advised to use a different method of group selection. If a group of qualified people would select the top students from several instrumental programs as the successful group and drop-outs from the same instrumental programs were used as the less successful group, the study might be strengthened.
3. Although the psychomotor tests utilized in the present study were related to success in beginning instrumental programs, it would be very valuable if a separate study were undertaken in which the purpose was to discover psychomotor tests which were related specifically to movements involved in instrumental performance.
4. It would be of great usefulness if instrumental teachers would begin to consider differences among students in psychomotor skills when

attempting to evaluate the probable success of those students in the instrumental program.

5. If one were to replicate the present study, it would be interesting to include a personality inventory as one of the variables. Some of the literature seems to demonstrate a strong relationship between personality traits and success in music.

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APPENDIX A

Form Used by Band Directors

Dear Band Director,

For my study, I will need your cooperation in obtaining the following information:

In the space provided below, please divide your beginning band students into three categories: high, middle, and low. Consider such things as tone quality, technique, musical reading ability, rhythmic reading ability, and general musicianship in dividing your students into the categories.

I would like for your group to be divided as evenly as possible into the three categories. For example, if you have twelve students, there should be four students placed into each category.

If you have any questions, please feel free to call me. My telephone number is 292-3457.

Thank you for your cooperation.

Sincerely,

Ron Hufstader

HIGH	MIDDLE	LOW
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.
6.	6.	6.
7.	7.	7.
8.	8.	8.
9.	9.	9.
10.	10.	10.

APPENDIX B

Raw Scores of Subjects on Variables

High Group

Subject	Rotary Pursuit Apparatus	Visual Choice Reaction Timer	Tachistoscope	Tapping Board	Test of Musicality	Intelligence	Academic Achievement
1	2.013	2.304	22	102	34	121	3.5
2	3.245	2.201	21	132	27	125	3.8
3	.667	2.810	16	123	16	123	3.7
4	2.737	2.140	20	103	33	115	3.2
5	6.133	2.440	24	95	27	121	4.0
6	7.624	2.457	18	100	28	115	3.2
7	2.691	2.458	20	93	16	102	4.2
8	1.145	2.485	17	95	26	90	3.3
9	2.117	3.681	14	101	20	114	3.1
10	3.747	2.317	20	109	22	102	5.2
11	.729	2.208	20	109	26	120	3.5
12	1.005	1.029	23	106	21	105	4.7
13	6.734	2.178	18	104	20	114	2.7
14	.737	1.735	20	106	21	127	3.7
15	.260	2.024	19	103	18	114	3.8
16	1.391	2.263	18	121	13	102	4.1
17	.986	2.504	19	90	26	129	4.4
18	1.097	2.051	18	87	24	114	3.8

Low Group

Subject	Rotary Pursuit Apparatus	Visual Choice Reaction Timer	Tachistoscope	Tapping Board	Test of Musicality	Intelligence	Academic Achievement
19	1.581	2.368	22	109	22	122	3.6
20	6.578	2.718	18	144	28	120	3.6
21	.405	3.224	19	99	16	106	3.0
22	4.681	2.056	20	123	24	118	3.1
23	8.177	2.399	22	108	24	95	2.7
24	3.708	2.770	15	84	21	101	2.9
25	4.430	2.656	19	102	15	97	2.9
26	14.043	3.270	18	125	20	116	3.2
27	2.603	3.050	15	100	16	75	3.6
28	2.795	2.167	12	90	19	102	4.1
29	1.731	1.870	11	87	20	101	3.7
30	1.064	1.963	22	113	10	99	4.9
31	1.447	3.087	17	124	16	81	4.3
32	.062	2.336	14	69	13	98	2.8
33	2.012	2.265	20	117	28	105	3.2
34	2.250	2.471	17	109	6	117	3.7

APPENDIX C

Output of BMD07M

PROBLEM CODE DFS

NUMBER OF VARIABLES 7

NUMBER OF GROUPS 2

NUMBER OF CASES IN EACH GROUP 18 16

PRIOR PROBABILITIES 0.5000 0.5000

VARIABLE FORMAT (3X,F5.3,1X,F3.3,1X,F2.0,1X,F5.0,1X,F2.0,1X,F5.0,1X,F3.1)

DATA INPUT FROM CARDS

MEANS (THE LAST COLUMN CONTAINS THE GRAND MEANS OVER THE GROUPS USED IN THE ANALYSIS)

VARIABLE	GROUP 1	GROUP 2	
1	[illegible]	3.60775	3.92073
2	2.21360	2.59161	2.41088
3	15.27777	17.56250	16.47058
4	104.24889	106.43750	105.35294
5	23.22221	13.62500	21.05882
6	114.05556	102.91750	107.00000
7	3.77222	3.45625	3.62352

STANDARD DEVIATIONS

VARIABLE	GROUP 1	GROUP 2
1	2.22697	3.33962
2	[illegible]	[illegible]
3	2.46963	3.62476
4	[illegible]	16.57962
5	5.71952	6.07050
6	10.54960	15.54025
7	0.60760	0.60439

WITHIN GROUPS COVARIANCE MATRIX

VARIABLE	VARIABLES 1	2	3	4	5	6	7
1	5.90214						
2	0.33348	0.23247					
3	1.51066	-0.40474	8.51087				
4	15.14268	0.67816	16.47235	233.31873			
5	5.60425	-0.16698	4.66572	10.97031	34.05179		
6	6.25186	-0.43026	8.40239	49.66935	19.34529	160.32422	
7	[illegible]	[illegible]	0.28539	1.52813	-1.04349	-1.12043	0.36736

WITHIN GROUPS CORRELATION MATRIX

VARIABLE	VARIABLES 1	2	3	4	5	6	7
1	1.00000						
2	0.25729	1.00000					
3	0.17635	-0.24577	1.00000				
4	0.29498	0.09214	0.38750	1.00000			
5	0.31464	-0.05937	0.23157	0.12201	1.00000		
6	0.19186	-0.07526	0.24175	0.27450	0.27814	1.00000	
7	-0.27515	-0.29296	0.16046	0.16900	-0.29387	-0.15605	1.00000

F-LEVEL FOR DELETION 0.0
TOLERANCE LEVEL 0.0
CONTROL VALUES 1111111

****

STEP NUMBER 0
VARIABLE ENTERED

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 32

1 1.2046 2 2.2467 3 2.6942 4 0.1524 5 5.1003 6 6.9668 7

****

STEP NUMBER 1
VARIABLE ENTERED 6

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 32

6 6.9668

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 31

1 2.0478 2 1.3534 3 0.9550 4 1.0694 5 2.0417 7 3.0346

U-STATISTIC 0.82121 DEGREES OF FREEDOM 1 1 32
APPROXIMATE F 6.96802 DEGREES OF FREEDOM 1 32.00

F MATRIX - DEGREES OF FREEDOM 1 32

GROUP
A
GROUP
B 6.96683

****

STEP NUMBER 2
VARIABLE ENTERED 7

VARIABLES INCLUDED AND F TO REMOVE.- DEGREES OF FREEDOM 1 31

6 7.0630 7 3.0346

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 30

1 0.9206 2 0.3801 3 0.3505 4 1.8548 5 3.3801

U-STATISTIC 0.74799 DEGREES OF FREEDOM 2 1 32
APPROXIMATE F 5.22221 DEGREES OF FREEDOM 2 31.00

F MATRIX - DEGREES OF FREEDOM 2 31

GROUP
A
GROUP
B 5.22222

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 30

5 3.3801 6 3.8881 7 4.3432

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 29

1 1.7420 2 0.1233 3 0.0079 4 2.1734

U-STATISTIC 0.67229 DEGREES OF FREEDOM 3 1 32
APPROXIMATE F 4.87547 DEGREES OF FREEDOM 3 30.00

F MATRIX - DEGREES OF FREEDOM 3 30

GROUP
A

GROUP
B 4.87547

****

STEP NUMBER 4
VARIABLE ENTERED 4

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 29

4 2.1734 5 3.6660 6 4.6837 7 5.4523

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 28

1 0.7236 2 0.0008 3 0.2269

U-STATISTIC 0.62538 DEGREES OF FREEDOM 4 1 32
APPROXIMATE F 4.34296 DEGREES OF FREEDOM 4 29.00

F MATRIX - DEGREES OF FREEDOM 4 29

GROUP
A

GROUP
B 4.34296

****

STEP NUMBER 5
VARIABLE ENTERED 1

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 28

1 0.7236 4 1.1266 5 4.0657 6 4.5681 7 5.3276

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 27

2 0.0140 3 0.2726

U-STATISTIC 0.60962 DEGREES OF FREEDOM 5 1 32
APPROXIMATE F 3.98598 DEGREES OF FREEDOM 5 28.00

F MATRIX - DEGREES OF FREEDOM 5 28

GROUP
A

STEP NUMBER 6
VARIABLE ENTERED 3

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 27

1 0.7505 3 0.2728 4 1.2547 5 3.0942 6 3.9028 7 2.6999

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 26

2 0.0776

U-STATISTIC 0.80355 DEGREES OF FREEDOM 6 1 32
APPROXIMATE F 2.95611 DEGREES OF FREEDOM 6 27.00

F MATRIX - DEGREES OF FREEDOM 6 27

GROUP
A

GROUP
B 2.95612

****

STEP NUMBER 7
VARIABLE ENTERED 2

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 26

1 0.7912 2 0.0776 3 0.3274 4 1.3276 5 3.0599 6 3.8918 7

U-STATISTIC .80178 DEGREES OF FREEDOM 6 1 26
APPROXIMATE F 2.95135 DEGREES OF FREEDOM 7 26.00

F MATRIX - DEGREES OF FREEDOM 7 26

GROUP
A

GROUP
B 2.95134

F LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

	FUNCTION	
	A	B
VARIABLE		
1	-0.97724	-0.61507
2	23.14171	22.81293
3	1.09592	1.50023
4	-0.02413	0.01915
5	0.78419	0.62522
6	0.87062	0.78575
7	16.02930	16.51926
CONSTANT	-135.82437	-116.12459

GROUP WITH LARGEST PROB. | SQUARE OF DISTANCE FROM AND POSTERIOR PROBABILITY FOR GROUP -

GROUP A B

```
   4          A   3.595 0.888,    7.737 0.112,
   5          B   8.[illegible] 0.939,   14.476 0.061,
   6          B   9.512 0.609,    5.195 0.391,
   7          A   4.026 0.583,    4.694 0.417,
   8          B   6.550 0.356,    5.361 0.644,
   9          B  10.075 0.447,    9.650 0.553,
  10          A   8.149 0.867,   11.903 0.133,
  11          A   1.633 0.874,    5.512 0.126,
  12          A   8.955 0.850,   12.423 0.150,
  13          B   8.199 0.144,    4.658 0.856,
  14          A   3.460 0.881,    7.473 0.119,
  15          A   1.679 0.686,    3.246 0.314,
  16          B   6.289 0.172,    3.141 0.828,
  17          A   8.510 0.992,   18.139 0.008,
  18          A   1.721 0.899,    6.063 0.101,

GROUP                    A                B
      B
 CASE
   1          A   2.287 0.853,    5.798 0.147,
   2          B  10.084 0.457,    9.737 0.543,
   3          B   9.256 0.295,    7.545 0.705,
   4          B   5.191 0.381,    4.218 0.619,
   5          B  13.370 0.067,    8.105 0.933,
   6          B   5.475 0.237,    3.133 0.763,
   7          B   9.138 0.050,    3.248 0.950,
   8          B  20.429 0.065,   15.097 0.935,
   9          B  13.700 0.029,    6.676 0.971,
  10          B   9.120 0.442,    8.655 0.558,
  11          B  12.126 0.341,   10.804 0.659,
  12          B   9.372 0.417,    8.701 0.583,
  13          B  14.521 0.073,    9.444 0.927,
  14          B  11.726 0.139,    8.077 0.861,
  15          B   5.172 0.499,    5.167 0.501,
  16          B  11.393 0.154,    7.961 0.846,

          NUMBER OF CASES CLASSIFIED INTO GROUP -
              A      B
GROUP
      A      14      4
      B       1     15
```

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	VARIABLE REMOVED	F VALUE TO ENTER OR REMOVE	NUMBER OF VARIABLES INCLUDED	U-STATISTIC
1	8		6.9668	1	0.8212
2	7		3.0356	2	0.7580
3	5		3.3801	3	0.6722
4	4		2.1739	4	0.6259
5	1		0.7233	5	0.6076
6	3		0.2726	6	0.6035
7	2		0.0776	7	0.6017

EIGENVALUES

0.66186	0.00000	0.00000	=0.00000	=0.00000	=0.00000	=0.00000

CUMULATIVE PROPORTION OF TOTAL DISPERSION

1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

CANONICAL CORRELATIONS

0.63108	0.00061	0.00036	0.00052	0.00068	0.00093	0.00139

COEFFICIENTS FOR CANONICAL VARIABLE =

ORIGINAL VARIABLE	1	2	3	4	5	6	7
1	0.10888	=0.16867	=0.01637	=0.06667	=0.00853	0.35687	=0.03851
2	=0.20792	=1.03950	=0.02057	0.00930	0.00023	=1.13110	=0.24671
3	=0.07190	=0.00520	=0.02729	0.08750	=0.06021	=0.06855	=0.37750
4	0.02737	0.03567	0.01957	0.05206	=0.01397	=0.00181	0.04137
5	=0.10093	0.01741	=0.14212	0.02097	=0.03293	0.00270	0.07701
6	=0.05304	=0.01288	0.08531	0.00114	0.05839	0.01459	0.00730
7	=0.95496	=1.36608	0.23362	=0.00907	=0.87539	0.23669	0.49857

GROUP	CANONICAL VARIABLES EVALUATED AT GROUP MEANS						
1	=0.76612	0.00000	0.00000	0.00000	=0.00000	=0.00000	=0.00000
2	0.83713	0.00000	0.00000	0.00000	=0.00000	0.00000	=0.00000

CHECK ON FINAL U-STATISTIC 0.60174

POINTS PLOTTED ON THE FOLLOWING GRAPH

A = FIRST CANONICAL VARIABLE
Y = SECOND CANONICAL VARIABLE
CASE NUMBER FOLLOWED BY * INDICATES THE POINT IS OFF THE GRAPH

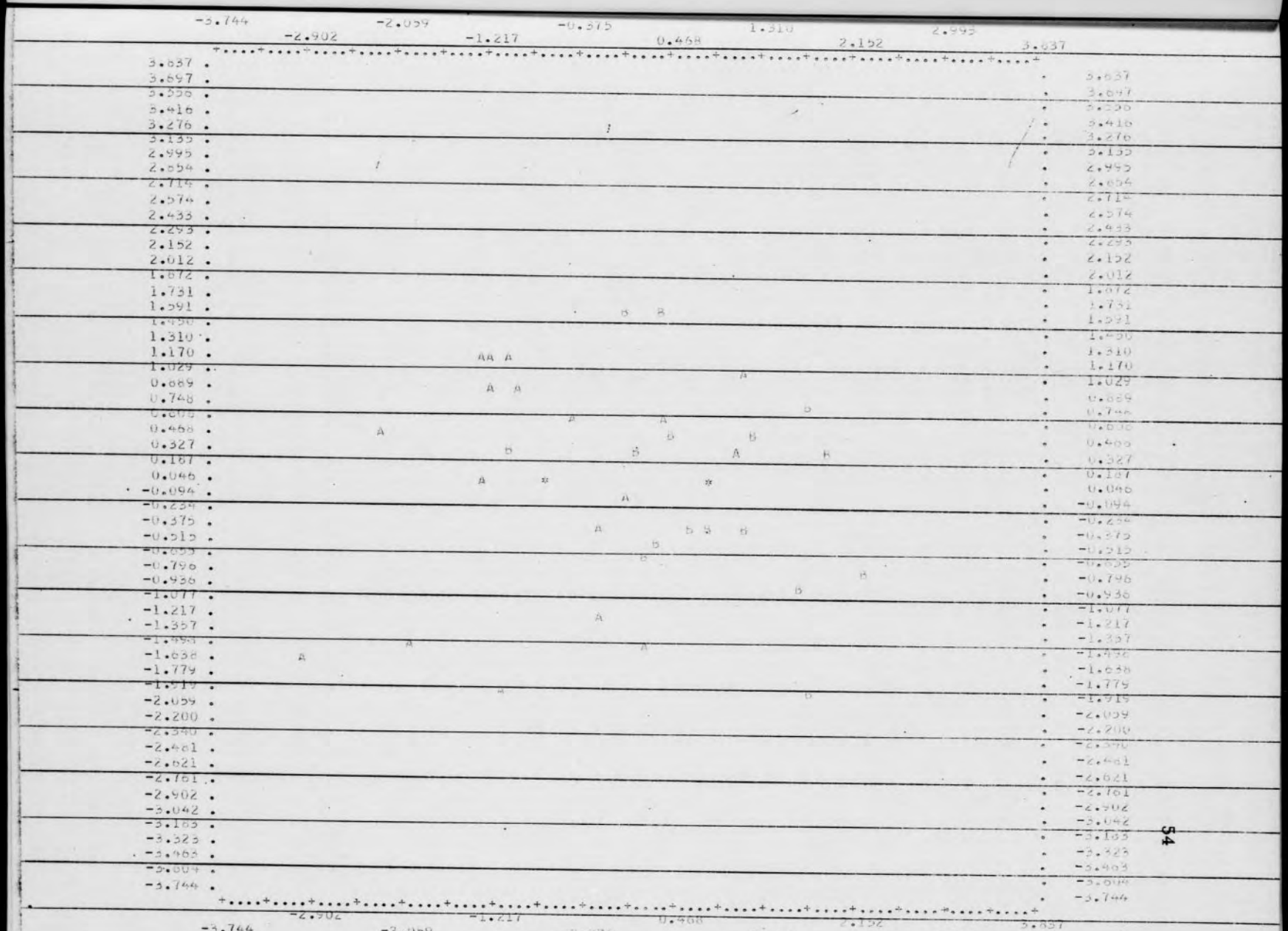
GROUP A MEAN COORDINATES -0.744 -0.000

CASE	A	Y			
1	-2.253	0.416	11	-1.180	0.907
2	-2.599	0.056	12	-1.030	1.151
3	0.014	-0.084	13	1.173	0.567
4	-1.283	1.106	14	-1.222	1.135
5	-1.942	-1.488	15	-0.449	0.000
6	-0.233	-0.326	16	1.042	0.345
7	-0.105	-1.265	17	-2.998	-1.632
8	0.423	0.571	18	-1.333	-0.010
9	0.101	-1.481			
10	-1.100	-1.880			

GROUP B MEAN COORDINATES 0.557 -0.000

CASE	A	Y			
1	-1.064	0.260	11	0.464	0.479
2	0.156	0.347	12	0.239	-0.524
3	0.597	-0.390	13	1.052	-0.867
4	0.394	1.505	14	1.260	0.435
5	1.711	0.008	15	0.048	1.542
6	0.786	-0.339	16	1.126	-0.314
7	1.909	0.295			
8	1.755	-1.895			
9	2.208	-0.792			
10	0.194	-0.650			

OVERLAP IS INDICATED BY S, GROUP MEANS BY *.


-3.744
-2.902
-2.059
-1.217
-0.375
0.468
1.310
2.152
2.993
3.837
3.837
3.697
3.556
3.416
3.276
3.135
2.995
2.854
2.714
2.574
2.433
2.293
2.152
2.012
1.872
1.731
1.591
1.450
1.310
1.170
1.029
0.889
0.748
0.608
0.468
0.327
0.187
0.046
-0.094
-0.234
-0.375
-0.515
-0.655
-0.796
-0.936
-1.077
-1.217
-1.357
-1.498
-1.638
-1.779
-1.919
-2.059
-2.200
-2.340
-2.481
-2.621
-2.761
-2.902
-3.042
-3.183
-3.323
-3.463
-3.604
-3.744
-3.744
-2.902
-2.059
-1.217
-0.375
0.468
1.310
2.152
2.993
3.837