THE RELATIONSHIP OF MUSICAL APTITUDE AND INTELLIGENCE

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AN ABSTRACT

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THE RELATIONSHIP OF MUSICAL APTITUDE AND INTELLIGENCE

An Abstract of the Study

The purpose of the study was to investigate the relationship between intelligence as measured by the Wechsler-Bellevue and musical aptitude as measured by the Seashore Measures of Musical Talent. Previous studies of this nature had failed to take into account the amount of musical training of their subjects. Some had also failed to secure adequate measurements of intelligence or musical aptitude or both, and others had failed to secure subjects with a sufficiently wide range of intelligence. This study was designed to correct these methodological defects.

The Seashore Measures of Musical Talent were administered to a group of 180 boys ranging in age from 12-8 to 17-8. Wechsler-Bellevue I.Q.'s were available for all subjects. All subjects in the sample having more than 200 hours of musical instruction were eliminated, leaving a total of 176 subjects.

The 176 remaining subjects were arranged into three groups. One group (referred to as the low group) consisted of 53 boys with an age range of 13-3 to 17-8 and a mean age of 15.78years. The range of

I.Q.'s in this group was 58-82, with a mean I.Q. of 75.64. The mean hours of musical training for this group was 11.8. A second group (referred to as the high group) consisted of 48 boys with an age range of 14-2 to 17-6, and a mean age of 16.07 years. The range of I.Q.'s in this group was 111-139, with a mean I.Q. of 118.04. The mean hours of musical training for this group was 9.8. The third group (referred to as the normal group) consisted of 121 boys with an I.Q. range of 58-139, a mean I.Q. of 98.355, and a standard deviation of 23.49 I.Q. points.

The significance of the differences between the means of the high and low groups on each of the individual Seashore subtests, and on total composite Seashore score were tested by application of Fisher's t for uncorrelated samples. All differences were found to be very significant (Beyond the 0.01 level of confidence).

The I.Q.'s of the normal group were correlated with their scores on each of the individual Seashore subtests, and with their total composite Seashore score by computation of Pearson product-moment coefficients of correlation. Positive, significant (beyond the 0.01 level of confidence) correlations were found between I.Q. and all Seashore scores, with the exception of the pitch subtest. The correlation between I.Q. and the pitch subtest was positive, low, and not significant.

The results of this study indicate a positive and significant relationship between total musical aptitude, as measured by the Seashore test, and intelligence throughout a wide range of I.Q.'s. They also indicate a positive and significant relationship between the elements of musical aptitude as measured by the Seashore subtests -- with the exception of the element of pitch -- and intelligence throughout a wide range of I.Q.'s. The ability to discriminate differences in pitch appear to be related to intelligence only at the extremes of the I.Q. range.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Statement of the Problem	3
Review of the Literature	5
PROCEDURE	16
RESULTS	23
DISCUSSION OF RESULTS	29
REFERENCES	34

LIST OF TABLES AND FIGURES

TABLE Page

I. Composition of High and Low Groups 19

II. Performance of High and Low Groups on Seashore 24

III. Differences Between Means, Standard Errors of Differences, and t Ratios Between High and Low Groups 24

IV. Correlations Between I.Q. and Seashore Tests 27

FIGURE

1. Distribution of I.Q.'s in Correlation Group 22

INTRODUCTION

The problem of the role of intelligence in specific aptitudes has recieved much attention from psychologists, educators, and psychometricians. Viewpoints on this problem appear to run from one extreme to another, apparently according to the degree of sophistication, theoretical orientation, and personal bias of the particular individual.

At the one extreme is the position that clearly defined abilities exist which are separate from intelligence and are not dependent upon it in any way. The exponents of this viewpoint would hold that a given individual can possess or be endowed with any amount of a special aptitude regardless of his level of intelligence, and can therefore perform with utmost skill the activity related to or dependent upon the aptitude even though he be intellectually inferior--or possibly defective. This would appear to be the reasoning underlying the concept of the idiot-savant which appears periodically in the literature. No less an authority than Hollingworth (11) expressed the conviction that intelligence and aptitude are found separately. She stated that the belief in a correlation among various mental functions was unfounded, and that musical ability was an example

of an aptitude not correlated with intelligence. Musical ability was, she stated, based upon three factors: acoustic functions, motor functions, and intellectual functions. These were seen as separate, and she believed that a person could rate high in one and low in another. Thus she concluded that musical ability based on the first two could coexist with mediocre or even inferior intelligence.

A slightly modified form of the above viewpoint is expressed by Christensen and Karloski (3), who constructed an art appreciation test and administered it to sixty girls and fifty-one boys. The Thurstone psychological test No. 4 was also administered to these subjects. The authors found a positive but low correlation between the two tests and concluded that there is little if any real relationship between esthetic appreciation and the abilities measured by intelligence tests.

As another example, Lewerenz (14) stated that, while there seems to be a high correlation between intelligence and most abilities, there are two abilities which do not appear to have much relationship to intelligence; these are art and music. These abilities are, he stated, dependent upon factors other than those measured by intelligence tests. He believed that people with I.Q.'s above 85 can be successful in art or music, but that the most outstanding in these fields will probably have high I.Q.'s.

Finally, the opposite pole of the controversy is expressed by Wechsler (22), who stated:

> Aptitudes do not exist in a vacuum, and in all cases the manifestation of intelligent behavior is not an expression of one simple cause but of a complex effect. Intelligence is not one entity, but a combination resulting from interactions. . . . Human qualities never exist as independent entities isolated from other characteristics, but always as the components of such a configurational total in which the parts are functionally related and mutually influential.

Thus, from the foregoing brief survey it can be seen that the question of the existence of discrete aptitudes unrelated to general intelligence is still unresolved. On reviewing the literature one fact does stand out, however: musical ability has been the special ability most often chosen for investigation in this context. The reasons for this choice have not been stated by the investigators, but it appears likely that the easily administered tests developed by Seashore, Kwalwasser and Dykema, and Drake, purporting to measure musical aptitude, have been an important factor.

Statement of the Problem

The purpose of this study is the investigation of the relationship between intelligence as measured by the Wechsler Bellevue and musical aptitude as measured by the Seashore Measures of Musical Talents.

Although many similar studies have been reported in the literature, the present study appeared to be justified on the basis of the following three criticisms, one or more of which appear to apply to all the previous studies.

Investigators have failed to obtain adequate measures of intelligence or musical aptitude or both. This is well illustrated in reports of cases of so-called idiot-savant. Bellows (2) reported three such cases: a case of "acquired feeblemindedness" with musical ability, a "female idiot of low grade" with unusual musical ability, and an "idiot boy" who plays the piano by ear. The author offered no real data on any of these cases. There is no mention of how he arrived at his estimates of intelligence, or by what standards he judged musical aptitude or proficiency in any of the three cases. Another example is a report by Owens and Grimm (15) of the case of a girl, age 23 years, Kuhlmann-Binet M.A. 3-7, I.Q. 23. The authors reported that this girl plays any piece that is sung, hummed, or played for her in the key in which she hears it. They rated her musical ability as "exceptional," but this rating was apparently based entirely on their own subjective judgments.

A second criticism that applies to all of the reported studies is that the amount of musical training received by the subjects has not been taken into account.

A third criticism is that in most instances the range of intelligence among the subjects has not been great enough to allow differences, which might depend upon differences in intelligence, to appear.

The present study has been designed to correct these methodological defects of previous studies in the hopes that a more accurate estimate of the relationship between intelligence and musical aptitude can thus be obtained.

Review of the Literature

One of the earliest and perhaps one of the most comprehensive works on the subject of musical aptitude is that of Seashore (17). He described the "musical mind" in terms of five factors. The first of these factors is musical sensitivity, which he subdivided into eight senses: pitch, intensity, time, extensity, rhythm, timbre, consonance, and volume. The remaining four factors are musical action, musical memory and imagination, musical intellect, and musical feeling. His measures of musical talent were designed as an objective measurement of the first factor, musical sensitivity. The remaining four, he stated, must be measured by other tests or by compiling a careful history of the person under consideration.

Seashore went on to state that musical talent is really a hierarchy of talents, many of which are entirely independent of one

another. It follows from this, he stated, that the description of a "musical mind" reduces itself to describing the relative prominence or latency of each musical talent. It was his opinion that the senses which comprise the factor or talent measured by his test have little relationship to general intelligence. He emphasized this particularly in the cases of pitch, intensity, and time.

In a later work Seashore (18) restated his former views in essentially the same way. He said that some children are born with "astonishing" musical skill entirely unsupported by intelligence, reason, or ability to make practical adjustments. Musical prodigies are, he declared, found in institutions for the feeble-minded, and many others are correctly classified as morons. No empirical evidence was offered for these conclusions, so it must be concluded that they represent only his opinion and not conclusions drawn from objective data. He did state, however, that, in general, the outstanding musical figures are usually also quite intelligent.

Kwalwasser (12), another authority on the psychology of music, appears to have held much the same viewpoint as Seashore. He stated that he believed Galton's law of regression to hold with music and intelligence test data. He was of the opinion that those who score very high on music tests score relatively lower on intelligence tests,

while those who score very low on music tests score almost average on intelligence tests. He further stated that those who score very high on intelligence tests score relatively lower on music, while those who score low on intelligence tests score almost average on music.

In an attempt to determine the relationship between musical talent and intelligence, Hollingworth (10) conducted a study with superior children. Her subjects were forty-nine children from the New York public schools, ranging in age from 8-0 to 11-5, and ranging in Stanford Binet I.Q. from 135 to 190. She administered five of the Seashore subtests--pitch, loudness, time, consonance, and tonal memory--to these subjects. She found that 42.8 percent of her sample exceeded the Seashore norms for age and grade placement on pitch, 44.9 percent on loudness, 65.3 percent on time, 44.9 percent on consonance, and 53.0 percent on tonal memory. Dividing the subjects into quartiles on the basis of I.Q., she found no significant differences in Seashore scores between the quartiles. On the basis of this study, Hollingworth concluded that above the level of intelligence required to understand directions on the Seashore tests, performance on the pitch, consonance, intensity, and tonal memory subtests is not related to intelligence. The judgment of short

intervals of time was, however, thought to have a small relationship to intelligence. She further concluded that performance on musical aptitude tests is related closely to C.A. in children, but is not related to M.A.

Fracker and Howard (6) reported a study in which they gave the Otis Self Administering Test of intelligence, the Army Alpha, and the Seashore Measures of Musical Talent to 230 university students. They stated that the range of I.Q. was found to be from 70 to 134, with a median of 107.3. Each subtest of the Seashore was correlated with I.Q. The highest correlation found was 0.32 ± 0.04 between pitch and I.Q. The authors concluded that musical aptitude test scores were not related significantly to intelligence. This study appears to be open to question on two points. The investigators made no attempt to control for the amount of musical training and practice of their subjects. Secondly, one finds it rather difficult to conceive of college students with an I.Q. of 70, as reported in this study, and is inclined to wonder if these low scores represent some error of measurement or calculation.

Drake (5) reported a study in which he gave twelve music tests and one intelligence test to a group of 163 boys. He did not specify the intelligence test used in the study, nor did he report the

age and intelligence range of his subjects or the amount of musical training they had received, if any. The music tests used were the six subtests of the Seashore, the musical memory, interval discrimination, and retentivity subtests of the Drake, the melodic taste and tonal movement subtests of the Kwalwasser-Dykema, and the Lowery cadence test. He reported correlation coefficients ranging from 0.07 between intelligence and Seashore consonance to 0.33 between intelligence and Drake interval discrimination. The author concluded that, when "relatively pure" measures of musical talent such as the Seashore are used, there is no significant relationship between intelligence and musical talent.

In an early study, Telson (21) gave the Seashore and the A.C.E. tests to 382 college students in an effort to determine if either or both of these tests could be used to predict term grades in music courses. His sample was composed of 240 music majors and 142 who were not majoring in music. He found a correlation of 0.40 between Seashore scores and term grades, and a correlation of 0.34 between A.C.E. scores and term grades, indicating that the A.C.E. and Seashore were nearly equally effective as predictive instruments, but that neither was effective enough to use as a basis of selection.

Lamp and Keys (13) conducted a study to determine if aptitude for performance on a musical instrument could be predicted by

either musical aptitude or intelligence tests. The Terman group test and the pitch and tonal memory subtests of the Seashore were given to the experimental group. These tests were followed by periods of carefully controlled uniform practice and instruction on an instrument. At the end of the instruction period, teachers rated the subjects as to degree of proficiency on the instrument, and these ratings were correlated with the test scores. A correlation of 0.25 was found between the Terman group test and ratings of proficiency, and a correlation of 0.42 between the Seashore subtests and ratings of proficiency. The investigators stated that a combination of all test scores gave a slightly higher correlation with ratings of proficiency, but they did not report the actual correlation. They concluded that none of the correlations was high enough to use the tests--either singly or in combination--as predictive instruments, and that aptitude for instrumental music is so specialized it cannot be predicted by tests of intelligence or musical aptitude.

A much more extensive study was reported by Ross (16), which was aimed at determining the relationship between intelligence, scholastic achievement, and musical aptitude. The subjects were 1,541 children in the California school system. Grade placement ranged from the fifth to the twelfth grades. The Seashore, Terman group

test, and Stanford Achievement Test were given. The age range and range of I.Q.'s of the subjects were not reported, and there was no mention of any attempt to control for amount of musical training. The investigator used the Otis correlation chart to compare I.Q. and musical aptitude. I.Q. was correlated with each Seashore subtest for each grade group. In general, low positive correlations were found, and the author concluded that there was no significant relationship between I.Q. and the six elements of the Seashore. A significant correlation between Stanford Achievement scores and the pitch and tonal memory subtests of the Seashore was found. From the experimental group the investigator then selected two groups, one with superior Seashore scores and one with low Seashore scores. These two groups were then compared for I.Q., and the difference between means was found to be 15 points in favor of the group with superior Seashore scores. No test of significance was reported. The final conclusion from the study was that superior musical ability is related to superior intelligence, and poor musical ability is related to inferior intelligence.

The relationship of intelligence to the more academic aspects of music was investigated by Farnsworth (7). The subjects in this study were a group of college students who were taking courses in

music theory, music appreciation, and history of music. Farnsworth administered two intelligence tests to these students, the Thurstone and the Iowa High School Content, and also the pitch and tonal memory subtests of the Seashore. These tests were correlated with term grades in the music courses. Intelligence test scores were found to correlate highest with grades in history of music and music appreciation. The intelligence tests and the Seashore subtests were found to correlate equally well with the grades in music theory.

As can be seen from the foregoing studies, the data concerning the relationship of intelligence to musical aptitude are far from conclusive. Most studies have been poorly controlled, and results have been conflicting. It appears that nothing which could have been considered a definitive study has been attempted. In a review of musical aptitude studies, Beinstock (1) concluded that we do not yet have the answer to the relationship between intelligence and musical aptitude. In her opinion this is due to the fact that musical aptitude tests are inadequate measures of musical aptitude. She further concluded that, since most studies with large N's show positive but low correlations, it seems probable that a high degree of musical aptitude is usually accompanied by superior intelligence, and, conversely, a low degree of musical aptitude is often associated with inferior intelligence.

The effect of musical training and practice on musical aptitude test scores has not been taken into consideration in any of the reported studies on the relationship of musical aptitude to intelligence. The question has also been the subject of controversy in the past. Seashore (17) believed that his Measures of Musical Talent were "pure," and that performance on them was not affected by practice or musical training.

To test the effect of training on musical aptitude test scores, Stanton and Koerth (19) administered the Seashore to a group of 645 children and 157 adults. They repeated the test several times on the subjects over a three-year period of musical training. Their findings were that the children's scores increased; the scores of the youngest children increasing the most. The adult scores were found to increase little. The authors concluded that musical training has no significant effect on scores on the Seashore tests.

In a later study Stanton (20) reported on the results of retests on a single Seashore subtest--pitch--with musical training interspersed between tests. The subjects for this study were grade school children. She found that the pitch scores increased, and that the increase was greater with longer periods of training and practice. She attributed the increase to the effects of general maturation, however, rather than to the effects of musical training.

Drake (4) repeated the Seashore pitch, Drake musical memory, and Kwalwasser-Dykema tonal memory tests on children after several years of musical training. He concluded from his results that there was no more improvement in the scores than that attributable to maturation, and provided for in the test age norms.

In the foregoing studies, test-retest differences in musical aptitude scores, when found, have been attributed to factors other than musical training. An extensive and carefully controlled study by Gilbert (8) suggests that previous studies did not give sufficient credence to practice and training effects, and that noted differences in musical aptitude scores were too quickly attributed to factors other than training and practice when training had intervened between test and retest. In this study, Gilbert administered the Kwalwasser-Dykema tests to 1,000 students--500 male and 500 female--in twelve Eastern colleges. All tests were given by the author. He found a significant difference between group means on this test in favor of the females. He also found that the females in the sample had had nearly three times as much musical training as the males. The subjects who had had musical training were then eliminated and the mean scores of the untrained males and the untrained females were compared. The differences were thereupon found to have disappeared.

Thus, when the groups were equated for musical training, the original apparent difference in musical aptitude was shown to be a function of the differences in amount of musical training in the two groups.

Thus, on the question of the effects of musical training on musical aptitude test scores, we seem to have what at least closely approaches definitive evidence. Although this evidence can, in the strictest sense, be said to apply only to the Kwalwasser-Dykema test, it does appear to furnish a fairly sound basis for considering the effects of training and practice in any musical aptitude study.

PROCEDURE

The subjects for this study were 180 boys, all inmates of a training school for delinquent boys. The age range of the group was 12-8 to 17-8. Either Wechsler-Bellevue or Wechsler Intelligence Scale for Children scores were available for all subjects, the tests having been administered at the time the subjects entered the institution, some by the author and some by his co-workers.

The subjects were chosen from this institution for the following reasons. The boys at this school possessed a sufficiently wide range of intelligence for the purposes of this study, and thus the entire sample could be drawn from the one institution and differences in co-operativeness, attitude toward test taking, present interests, and other factors that might be affected by environment or institutionalization would be minimized. As was previously mentioned, intelligence test scores and a variety of other data on these subjects were available, thus making matching and selection on the bases of various criteria readily feasible. The subjects were all familiar with psychological testing, all having been subjected to a battery of tests upon admission to the institution and to various other tests during their stay there. All the above factors appeared to assure

a more homogenious sample than could have been obtained by drawing the subjects from schools and institutions, as would have otherwise been necessary to obtain the desired intelligence range at this age level. The fact that the sample was composed entirely of boys was not considered detrimental to generalizing from the results, since the work of Gilbert (8) has established the fact that sex differences in musical aptitude are not significant.

All six subtests of the Seashore Measures of Musical Talent were administered to the subjects. The Seashore was administered as a group test, the groups ranging in number of subjects from three to thirty-two. The testing was carried out over a period of five months, the same set of test records and the same phonograph being used on all subjects.

At the time the Seashore was administered, the approximate number of hours of previous musical training was determined for each subject by individual interview. All subjects who had had more than 200 one-hour lessons on a musical instrument were dropped from the sample. There was no way to control for practice on an instrument, as no accurate account of hours of practice could be obtained from the boys.

The 176 subjects retained in the sample were arranged into three groups as follows. All subjects with I.Q.'s above 110 were

grouped together. This group, which will hereinafter be referred to as the high group, was composed of forty-eight subjects. All subjects with I.Q.'s below 83 were grouped together. This group, which will hereinafter be referred to as the low group, was composed of fifty-three subjects. These I.Q.'s were chosen, on inspection of the entire sample, so as to give two groups, each with an N near 50, which would differ widely in I.Q. The age range of the low group was found to be 13-3 to 17-8, with a mean of 15.78 years. The age range of the high group was found to be 14-2 to 17-6, with a mean of 16.07 years. The mean I.Q. of the low group was 75.64 and the mean of the high group was 118.04. The mean number of hours of musical training was also computed for each group, and was found to be 11.8 for the low group and 9.8 for the high group.

Thus two groups were obtained, the mean I.Q.'s of which differed by 42.40 points, or more than two standard deviations on the Wechsler-Bellevue, but which were matched for age and amount of musical training. The composition of these groups is shown in Table I. The significance of the differences between the means of these two groups on each of the six subtests of the Seashore and on the total number of correct responses on the Seashore was tested by application of Fisher's t for uncorrelated samples.

TABLE I

COMPOSITION OF HIGH AND LOW GROUPS

Group	N	Age Range	Age Mean	I.Q. Range	I.Q. Mean	Mean Hours of Musical Training
High	48	14-2 to 17-6	16.07	111-139	118.04	9.8
Low	53	13-3 to 17-8	15.78	58-82	75.64	11.8

The third group consisted of 121 subjects with a normal, or near normal, distribution of I.Q.'s which was obtained by the following procedure. The total range of I.Q.'s of all 176 subjects was divided into five-point intervals and a bar graph showing the frequency of each interval for the entire sample was constructed. A normal-appearing curve was superimposed on this bar graph. For each I.Q. interval, the number of subjects falling beneath the curve was included in this third, or normal, group. In each I.Q. interval containing more than the desired number of subjects, as shown by the superimposed curve, each subject was assigned a code number. A person not connected with the study was then asked to pick at random the desired number of subjects from all the subjects in that interval.

This procedure was followed in order to utilize the data from the subjects with average or near-average I.Q.'s. The tests of

differences between means were designed to demonstrate any relationships between musical aptitude and intelligence when persons at the extremes of the I.Q. range were considered. It was also desired to investigate the possibility of a linear relationship between intelligence and musical aptitude along the entire I.Q. range, thus the necessity for this third group which would contain many subjects of near-average I.Q. which had not been included in the high and low groups, and only as many subjects with very low or very high I.Q. as were needed to make a normal distribution of I.Q.'s with a wide range.

The resultant group had a range of I.Q.'s from 58 to 139, with a standard deviation of 23.49, and a mean of 98.355. On inspection of this group, it can be seen that approximately 84 percent of the cases fall within ± one standard deviation from the mean. Thus it is apparent that the curve representing this sample is platykurtic, and that the distribution of I.Q.'s in the group deviates somewhat from the normal.

A Pearson product moment coefficient of correlation was computed between the I.Q.'s of the subjects in this third group and their scores on each of the six subtests of the Seashore, and between I.Q.'s and total number of correct responses on the Seashore.

Figure 1 shows the distribution of I.Q.'s in this third group. Seashore (17) reported the distribution of scores on the pitch, loudness, and time subtests of the Seashore Measures of Musical Talent to be essentially normal. The distributions of scores on the rhythm, timbre, and tonal memory subtests for this group were also found to be essentially normal.

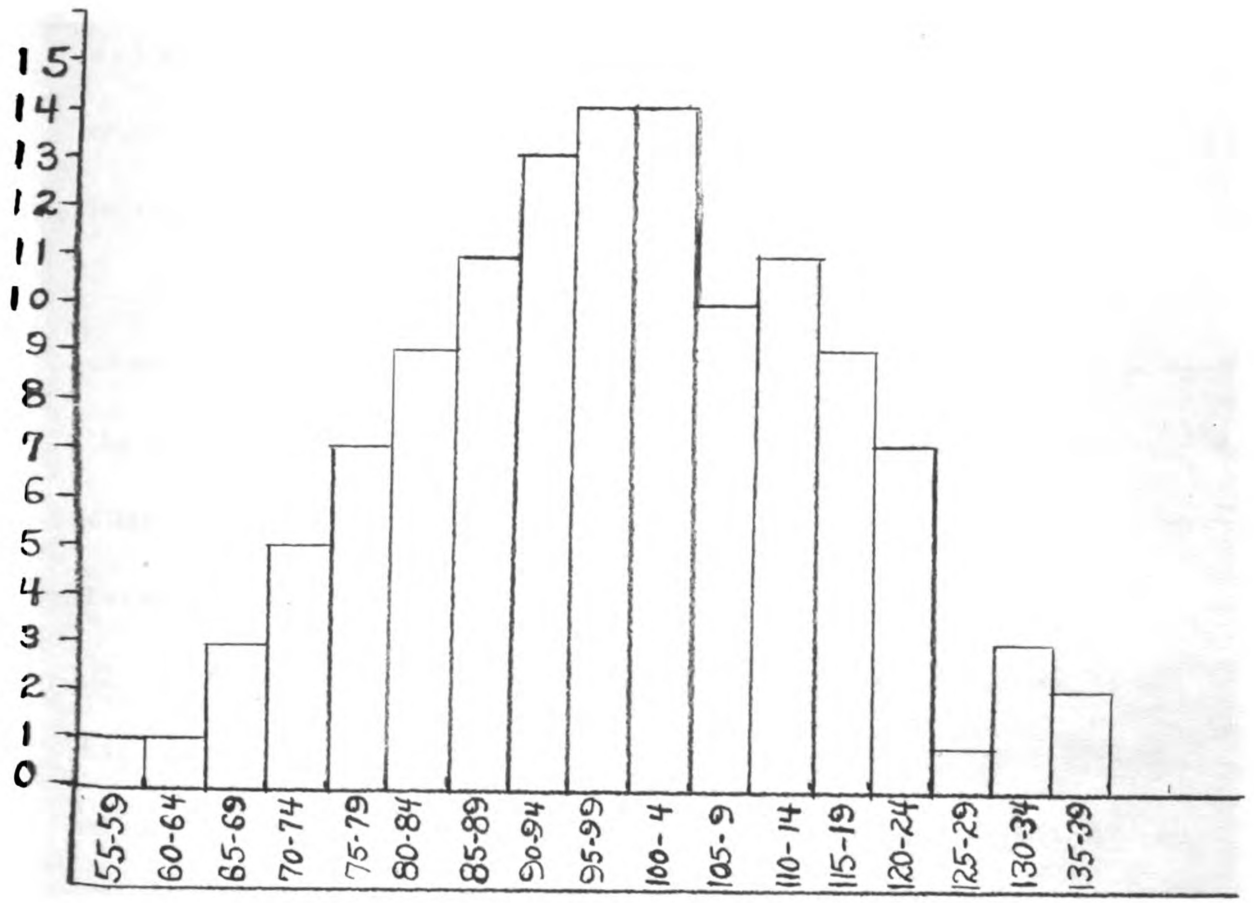

Figure 1. Distribution of I.Q.'s in correlation group.

RESULTS

The range of scores, means, standard deviations, and standard error of the means of both high and low groups on all six subtests of the Seashore are shown in Table II. Scores are expressed in number of correct responses for each subtest.

The differences between the means of the high and low groups, when tested by computing a t ratio, proved to be significant beyond the 0.01 level of confidence on all six subtests of the Seashore. The differences between means, standard errors of the differences between means, and the t ratios are shown in Table III.

As can be seen from Table II, the range of scores of the high group on the pitch and loudness subtests is greater than that of the low group. This is mostly a reflection of the fact that no subjects in the low group closely approached the scores of the higher scoring subjects of the high groups.

The greater range of scores of the low group on the rhythm, timbre, and tonal memory subtests is, on the other hand, mostly a reflection of the fact that the lowest scoring subjects in the high group did not closely approach the scores of the lowest scoring subjects in the low group.

TABLE II

PERFORMANCE OF HIGH AND LOW GROUPS ON SEASHORE

Subtest	High Group (N = 48)				Low Group (N = 53)			
	Range	M	σ	σ_m	Range	M	σ	σ_m
Pitch	18-48	37.06	5.65	0.82	14-41	28.21	5.99	0.83
Loudness	13-48	39.93	5.45	0.79	10-42	32.23	6.45	0.88
Rhythm	16-30	24.56	3.28	0.48	9-28	19.45	4.52	0.63
Time	21-46	38.81	5.51	0.80	19-46	31.49	5.17	0.72
Timbre	23-48	37.73	7.88	1.15	16-43	30.28	3.24	0.45
Tonal Memory.	13-30	23.67	4.34	0.63	5-26	13.32	4.64	0.64

TABLE III

DIFFERENCES BETWEEN MEANS, STANDARD ERRORS OF DIFFERENCES, AND t RATIOS BETWEEN HIGH AND LOW GROUPS

Subtest	$M_H - M_L$	σ_{DM}	t
Pitch	8.85	1.17	7.577
Loudness	7.70	1.18	6.525
Rhythm	5.11	0.79	6.468
Time	7.32	1.08	6.777
Timbre	7.45	1.23	6.057
Tonal Memory	10.35	0.90	11.500

The larger standard deviations of the low group on the pitch, loudness, and rhythm subtests are due mostly to the fact that the scores of high group subjects were clustered in the higher ranges, while scores of low group subjects were more evenly distributed over the middle and lower ranges.

The larger standard deviations of the high group on the time and timbre subtests are due mostly to the fact that the scores of the high group were rather evenly distributed over the middle and high ranges with very little clustering, while the scores of the low group were clustered in the lower middle ranges. This was particularly true in the case of the timbre subtest where the scores of the high group were nearly evenly distributed with little sign of a central tendency, while the scores of the low group were definitely clustered around the group mean of 30 correct responses.

On the tonal memory subtest the standard deviations of the two groups are almost identical. On this test the scores of both groups show a definite clustering; those of the high group in the higher ranges and those of the low group in the lower ranges. The extent to which tonal memory is related to intelligence is clearly brought out in Table III. Although all of the Seashore tests show highly significant differences in means in favor of the high group,

tonal memory, which, along with rhythm, is a 30-item subtest, shows a greater difference between means than the four 50-item subtests. The difference between means of the high and low I.Q. groups on this subtest is also significant at a far greater level of confidence than any of the other five subtests.

The total scores of the two groups, that is, the total number of correct responses on all six subtests, were also compared. The mean total of the high group was found to be 201.98, while the mean total of the low group was 156.51. The range of total scores for the low group was 119-194, and the range for the high group was 162-234. The difference between the mean totals of the two groups was 45.47 points, and t was found to be 11.801. As in the case of the individual subtests, this difference between the group means is significant well beyond the 0.01 level of confidence. Due to the large numbers involved, t for differences between total score means was computed by machine without first computing the standard deviations of the groups.

Correlations between I.Q. and Seashore scores of the third experimental group were computed by machine from original measurements. The obtained correlations and their levels of significance --according to the Wallace-Snedecor tables as reproduced by Guilford (9)--are shown in Table IV.

TABLE IV

CORRELATIONS BETWEEN I.Q. AND SEASHORE TESTS

Test	r	Level of Significance
Pitch	+0.077	Not sig.
Loudness	+0.629	Beyond 0.01
Rhythm	+0.356	Beyond 0.01
Time	+0.396	Beyond 0.01
Timbre	+0.368	Beyond 0.01
Tonal Memory	+0.496	Beyond 0.01
Total Score	+0.689	Beyond 0.01

From inspection of the raw data, it is apparent that there is a relationship between I.Q. and scores on the pitch subtest only at the extremes of the I.Q. range. In the middle ranges of I.Q. (85 to 115), pitch scores appear to vary in a random manner. Thus it would appear that any correlation obtained would reflect only relationship at the extremes of the range, and would necessarily be small. This is further borne out by the fact that the difference between mean scores of the high and low groups (which really represent the extremes of the I.Q. range) on the pitch subtest are very significant.

The obtained results indicate--in statistical terms--that the high and low I.Q. groups in this study could have been drawn by

chance from the same population of Seashore scores less than one time in one hundred. In the matter of correlation, one can conclude with a high degree of confidence (beyond the 0.01 level) that a real relationship exists between I.Q. and the Seashore subtests of loudness, rhythm, time, timbre, and tonal memory, and that that relationship is in the direction indicated by the algebraic sign of the obtained coefficients.

DISCUSSION OF RESULTS

The first and most obvious conclusion to be drawn from the results of this study is that groups of subjects with above average I.Q.'s are significantly higher in musical aptitude than groups with below average I.Q.'s. Perhaps it would be more conservative and rigidly accurate to say that groups of adolescent boys with I.Q.'s above 110 score significantly higher on those tests which purport to measure musical talent than do groups of adolescent boys with I.Q.'s below 83. However, if it is assumed that the Seashore tests are valid measures of musical aptitude, the first and broader statement would appear to be justified in view of the very highly significant differences demonstrated between the high and low groups in this study.

It appears obvious that the separation of 42.40 I.Q. points on the Wechsler-Bellevue scale which obtained between the high and low groups in this study is far greater than would be necessary to demonstrate significant differences in Seashore scores between two groups. It seems likely that a separation of 20 or less points between the mean I.Q.'s of two groups would be sufficient to demonstrate such differences. Future research could be directed toward determining

the minimum difference in I.Q. necessary to show consistent significant differences in musical aptitude test scores.

As can be seen from the ranges of scores for the individual Seashore subtests recorded in Table II, individuals of quite low I.Q. are sometimes capable of scoring high on one, or even two or three of the subtests. However, when it comes to scoring high on all--or even a majority--of the subtests, as is considered necessary to demonstrate musical talent, the low I.Q. subjects in this study fail without exception. This finding--the low total score of subjects with low I.Q. --is so consistent in this study that it would appear to cast doubt upon the possibility of an individual of very low intelligence possessing a high degree of musical talent. In other words, the musical idiot-savant seems highly improbable. It may be that if the reported cases of this phenomenon were re-examined more carefully, it would be found that the individuals in question were not mentally defective, but suffering from some other pathological condition which produced a pseudo mental deficiency.

Consideration of the nature of the relationship of the various Seashore scores to intelligence shows interesting variations among the subtests.

The ability to discriminate small differences between the loudness of two tones appears to have a very consistent relationship to

I.Q. Only in the normal range of intelligence (90 to 110) does there appear to be a somewhat random variation in this ability among the subjects of this study. Thus the scores on the loudness subtest show both wide average differences between groups with widely different intelligence levels, and a high relationship to intelligence in a group with a wide range of intelligence.

The ability to discriminate differences in rhythmic patterns, the ability to discriminate small differences in the length of time a tone is sounded, and the ability to hear slight differences in timbre between two sounds all appear to have a positive but low relationship to intelligence. Average differences in these abilities are large between groups with widely different intelligence levels, mainly because subjects with very low I.Q.'s tend to be poor in these abilities. As the I.Q. level of the subject increases, these abilities also increase, but not in a very consistent manner. Thus the scores on these subtests show wide average differences between groups with widely different intelligence levels, but only a low relationship to intelligence in a group with a wide range of intelligence.

As might be expected, adequate performance on the tonal memory subtest is heavily dependent on intelligence. As on any test of immediate recall, subjects of low I.Q. are very inept on this test.

As I.Q. increases, there is a steady, but not invariable, increase in performance on this test. It can be hypothesized that the factor being tested here is not so much the capacity for the immediate recall of tones, but the capacity for immediate recall per se.

The ability to discriminate small differences in pitch appears to have little relationship to intelligence. Subjects below 75 I.Q. do show a marked decrease in this ability, and subjects above 110 I.Q. show a slight increase. In the I.Q. range from 76 to 110, however, there is a random variation in this ability. It appears possible that the ability to discriminate differences in pitch may be dependent upon physiological factors that are not dependent upon intelligence. The differences in pitch scores between groups with I.Q.'s at the extremes of the intelligence range may well be due to differences between these groups in ability to concentrate on monotonous stimuli, rather than to differences in ability to discriminate differences in pitch.

In conclusion it can be said that the results of this study indicate a positive and moderately high degree of relationship between intelligence and musical aptitude, when total musical aptitude is considered rather than individual elements. It should also be noted that the correlation between I.Q. and total Seashore score obtained in this study is almost identical to the correlation obtained by Gilbert in an

incomplete and unpublished study of the relationship between intelligence and musical aptitude test scores. The scatter of abilities in separate elements or factors in musical aptitude tends to be narrow for persons at the extremes of the I.Q. range, and wide for persons in the middle of the I.Q. range. Consistently poor ability in all the elements tends to go with low I.Q., a variation of high and low abilities in the separate elements tends to go with average I.Q., and consistently high ability in all the separate elements tends to go with high I.Q.

As a final generalization, it appears probable that a very high degree of musical aptitude is found almost exclusively in persons of superior intelligence as measured by the Wechsler-Bellevue. It does not follow, however, that the individual with superior intelligence is necessarily superior in musical aptitude, for he may rank anywhere along the entire range of this aptitude. The important point is, however, that the very high rank in this aptitude is almost invariably accompanied by superior intelligence.

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