AN INVESTIGATION OF HEREDITARY AND ENVIRONMENTAL FACTORS IN MUSICAL ABILITY

by

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ABSTRACT

In the present investigation of hereditary and environmental factors in musical ability 78 parents and 67 children were tested with the Wing Standardised Tests of Musical Intelligence. Information on the amount of the subjects' playing, music lessons and listening was collected by questionnaires. Correlations of up to .475 were found between the parents' and children's Wing scores.

The Wing test was also given to 20 pairs of MZ child twins, 21 pairs of DZ child twins of like sex and 9 pairs of unlike sex. Results from 11 adult pairs were also used. The intra-pair MZ correlations ranged from .794 to .846 and those for the DZ pairs from .677 to .761 for twins of both sexes together. Heritability indices ranged from .262 to .423. The extent of intra-pair differences did not seem to be consistently related to age, interest in music, or amount of playing or lessons. Five pairs of identical twins brought up apart were also tested.

For the 25 cases where both parents could be tested, the father-child correlation, .627, on the Wing test was much higher than that for mother and child. The highest intra-pair correlation, .899, was found among the 10 pairs of MZ boy twins. The highest h^2 index, .617, was for the boy twins

considered separately. In neither case was the sex difference explicable on environmental grounds, as assessable from the questionnaire data.

The h^2 index for Wing test 3 (memory) was .532.

The general conclusion suggested by the present investigation and the past work in this field is that musical ability may have an important genetic component.

Other results appeared to confirm that a) musical ability is largely specific, and b) a broad factor of general musical ability is obtained, even when the Wing tests are applied to select groups.

An Investigation of Hereditary and Environmental Factors in Musical Ability

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INTRODUCTION

AIMS OF THE INVESTIGATION

How far any ability shown by an individual is acquired from the environment and how far it is innate is notoriously difficult to decide. Even in the case of general intelligence where this matter has been investigated and discussed on a considerable scale over a long period, wide divergences of opinion still exist. While statements drawing attention to the complex interaction of hereditary and environmental factors may be commendably cautious, they are hardly helpful when faced with problems of educational policy. If, for example, musical talent is very largely inherited it would not seem worth while schools spending too much time on the unmusical, who could rather be encouraged to indulge in other more profitable activities. Most of the effort should then be directed towards discovering and fostering the talent of the gifted. On the other hand, there is some evidence to suggest that at least pitch discrimination and singing ability can be significantly improved by training.

A relatively specialised ability like musical ability might appear somewhat easier to investigate than general intellectual ability. Indeed, before the days of the gramophone, radio and television, it might have been comparatively simple to obtain a fairly precise estimate of what music a child heard at home and the training he had received from school or individual lessons, though attention and interest would still have been important factors. The greatly increased opportunities of hearing good music professionally played in the home which exist nowadays have added to the environment a factor, the influence of which is difficult to assess. The psychology of incidental learning, of intermittent attention and of interest may be of some help in deciding what weight it should be given.

Music, like language, is obviously an acquired ability. Nevertheless, as with language, there may be innate aptitudes which are inherited and which may fundamentally affect the speed and level of learning.

Previous attempts to investigate the inheritance of musical ability have been carried out either by means of questionnaires or genealogical family trees, or, where tests have been used at all, those chosen have not been the most satisfactory from the point of view of reliability and validity. Little attempt has been made to apply the better validated tests of musical talent to comparisons of parents and children or to twins.

The present investigation deals with:

1. Parents and children. 67 children and 78 parents of two grammar schools in the Home Counties were tested with the Wing Standardised Tests of Musical Intelligence, and their scores compared. Data on instrument playing, music lessons, concert-going and listening at home were collected by means of questionnaires, which also included musical knowledge questions.

2. Twins. The musical ability, as measured by the Wing tests, of identical and fraternal twins, over 60 pairs altogether, was compared. In this instance, too, questionnaires to collect information on their musical knowledge and previous experience of music were included. Five pairs of the sample of identical twins brought up apart investigated by the M.R.C. Genetics Unit were similarly tested.

3. In addition, material made available to the writer by the Senior Psychologist's Department of the Admiralty was examined for further evidence on the relationship of musical ability to a) other cognitive abilities, b) educational background, c) social status, as indicated by the father's occupation, and d) spare-time interests.

4. Dr. Wing kindly supplied the writer with scores for his tests made by five groups viz. a) a highly talented group of 41 professional music students; b) a group of 100 training college students selected as being musically average;

c) a group of 100 gifted children from the National Youth Orchestra; d) a group of 100 male, and e) a group of 100 female students; the last two were of similar levels of ability. The scores for each group were factorized separately by computer. It was thought that a comparison of these factorial analyses might throw some light on certain problems in the psychology of music, e.g. on whether superior musical talent differs in kind as well as in degree from average and on the relative efficiency of the Wing subtests at different ability and age levels. Further, any differences found by comparing the fourth and fifth groups might help in investigating sex differences in music, e.g. the effect (if any) of the greater amount of encouragement and opportunity often given to girls, as compared with boys, in developing their musical ability.

"Musical ability" is the term generally adopted in the present thesis as being "the broadest and safest" term (Farnsworth, 1958, p.179), since it suggests the power to perceive and act without any _a priori_ implication of the extent of heredity. It is thus equivalent to Hebb's Intelligence B (Hebb, 1949). "Talent" is used similarly. On the other hand, "capacity" and "aptitude" are used for genetic potentiality, thus corresponding to Hebb's Intelligence A.

As suggested by Cattell (1950) "inherited" is taken to mean "acquired from the immediate parents or grandparents or more remote ancestors"; "inborn" or "innate" includes more than what is inherited, i.e. spontaneous mutations; while "congenital" equals "existing at birth", i.e. what is inborn and also what has been acquired *in utero*.

CHAPTER I

TESTS OF MUSICAL ABILITY

Introduction

This brief review of tests of musical ability attempts to cover only the more important.

Most effort has so far, for practical reasons, been directed towards developing and standardising tests suitable for group application. Mainwaring (Buros, 1959) has pointed out that not all aspects of musical aptitude can be assessed by group tests. This is perhaps particularly true of creative ability and for tests with younger children. Most batteries provide norms down to the ages of 7 or 8, but except for the musically brightest, the younger children are reported to find them difficult. Bentley has recently (1963) reported the development of tests especially suitable for children between 8 and 12. With children too young to record their own answers, it would seem a pity not to explore the possibilities of individual tests. The problem of standardising the scoring of results should not be insuperable.

At the other end of the scale, for subjects whose knowledge of musical notation can be taken for granted, but whose musical ability requires accurate assessment, e.g. for professional prognosis, there is probably a need for more tests like the Alferis Music Achievement test (see p.56 below).

In any discussion of the validity of musical tests, it is only fair to bear in mind the purpose for which the test was designed and the difficulties facing test authors in securing accurate ratings by class teachers in a subject like music.

Evidence on the effect of instrumental training on test scores is discussed in the course of the accounts of various tests mentioned below from the point of view of the prognostic value of the tests. It will be further considered from the point of view of how far musical ability can be modified by instrumental tuition in Chapter VIII.

Seashore's Measures of Musical Talent

Seashore's Measures of Musical Talent were the first attempt to measure musical ability scientifically. Among the purposes Seashore had in view in designing the measures were: (1) "to measure native and basic capacities in musical talent before training has been begun, and, therefore, to make them independent of musical training; (2) to measure one specific capacity at a time; (3) to make the procedure available for group measurements"; (Seashore, 1938, p.306). The tests, first published in 1919, were intended to measure the subject's capacity to perceive differences in pitch, time, intensity, and consonance, and to judge which tone in a sequence had been altered on a second playing. A rhythm test was added later. The revised version of 1939 replaced the consonance test (the least satisfactory of the earlier battery) by one on timbre and presented each measure in two forms: an easier and a more difficult one. The latter has since been withdrawn. A typical example of the measures is the pitch test, now consisting of 50 items. Two tones free of harmonics are sounded one after the other. The subject is required to state if the second is higher or lower than the first. The difference in pitch between the tones is graded down to 2 cycles per second.

The 1960 edition of the Test Manual provides percentile norms for fourth and fifth grades, sixth to eighth grades, and for grades 9 to 16, based on testing groups varying in numbers from 377 to 4319.

In interpreting the scores, Seashore insisted that they should be used to provide a profile for each variable and not averaged to give a composite score. In fact, according to Larson (Buros, 1949) in most cases those who have successfully used the tests have found a general classification based on composite scores quite satisfactory. Wing, (Buros, 1953, p.344) too, recommended the use of a total score for the Seashore battery, if only because the reliability of single tests is so much lower. For example, in the rhythm test which has 30 items, there is quite a high possibility of an average subject gaining or losing 2 marks through lucky or unlucky guessing. This shift of +2 to -2 from his true score would considerably change his percentile rank. The better results obtained by using a composite score might also be partly due to musical aptitude being more dependent on a sum total of abilities and their interaction than on the degree of each single one.

Seashore envisaged his measures being used at any racial or cultural level. For use in a culture very different from the American, there would seem to be a need to develop local norms. The scores made by 192 boys and 83 girls in a high school in India did not follow the pattern set by Seashore (Parthasarathy, 1957).

Seashore claimed that a reliability co-efficient of above 90 could be obtained on retest under ideal laboratory conditions. Much lower coefficients have, however, been reported by users of the tests. Lundin (1953, p.204), summarised the reliability studies for the 1919 version as follows:

Table I. Reliability Studies on the 1919 Seashore Measures (after Lundin)

Investigator	Method	Pitch	Intensity	Time	Rhythm	Tonal Memory	Consonance
Brown (1928)	Retest	.71	.65	.48	.29	.59	.43
Highsmith (1929)	Retest	.76	.50	.52		.83	.53
Lanier (1927)	Retest	.68	.60	.50	.43	.74	.54
	Split-Half	.84	.67	.64	.35	.60	.45
Stanton (1935)	Retest	.54	.80	.45		.83	.62
		.64	.64	.58		.90	.54
	Split-Half	.60	.82	.67		.83	.46
		.51	.78	.66		.90	.58
Mursell (1932)	Split-Half	.66	.86	.81	.64	.88	.52
Drake (1933)	Split-Half	.72	.85	.68	.68	.94	
		.84	.88	.70	.48	.86	.30
Farnsworth (1931)	Split-Half	.74	.72	.41	.43	.83	.33
		.75	.61	.46	.47	.81	.36

From the above table, Lundin concluded that the pitch and tonal memory tests appeared to be the most satisfactory; these are the only two which Farnsworth (1931) considered sufficiently reliable to have diagnostic value.

Seashore, Lewis and Saetveit (1960) quote the following reliability coefficients, calculated by the Kuder-Richardson formula, for the revised version of the tests:

	Grades 4-5	Grades 6-8	Grades 9-16
Pitch	.82	.84	.84
Loudness (Intensity)	.85	.82	.74
Rhythm	.67	.69	.64
Time	.72	.63	.71
Timbre	.55	.63	.68
Tonal Memory	.81	.84	.83

Where the coefficients are relatively low the authors emphasise the importance of interpreting scores in broad categories only and of retesting if important decisions are to be based on doubtful performances. Retesting, however, may create other problems, e.g. how far the later results have been influenced by practice. Particularly in the case of musical subjects, lower scores may be obtained, since they are liable to become bored (see Franklin, 1956, pp.87-97; Wyatt, 1945).

McLeish (1950), instructed his subjects not to guess when doubtful, but to record "E" (for "equal"). With this method, he claimed that the split-half reliability was raised to .90 for the whole battery (1919 Version), the subtests ranging from .65 to .86.

While it may be possible to improve the reliability of the Seashore measures by such procedures, the repeatedly expressed doubts as to their ~~lack of~~ validity have still to be answered. The validity Seashore claimed for his tests is "an internal validation in terms of success in the isolation of the factor measured and the degree of control of all other factors in the measurement", (1938, p.384). Seashore's critics such as Mursell and Wing do not deny that the pitch discrimination test, for example, is an objective and valid test of sensory capacity. But they do question whether the results of such testing have much relevance to functional musical ability.

Stanton attempted to validate the measures in a prolonged experiment at the Eastman School of Music. Entrants to the School were divided into five classes: "discouraged, doubtful, possible, probable and safe", on the basis of the test scores, combined with measures of tonal imagery and intelligence, and case histories. Of the discouraged group, 17% completed the four years' course in the standard time; compared with the 60% of the safe group who successfully graduated. This procedure has greatly improved the quality of the student body (Farnsworth, 1961).

However, the predictive value of the Seashore tests alone cannot be determined from these results. Lundin (1958), therefore, suggested that a repetition of the Stanton-type of study should be undertaken using the revised version of the Seashore tests, perhaps the Drake (see p. 34 below) tests and other measures. The results should be presented so that the specific contribution of the music tests, intelligence, case history etc. can be seen.

The validation studies of the 1919 Version based on empirical criteria indicate that the pitch and tonal memory tests seem to be the best; but apart from a comparison with sightsinging scores by Salisbury and Smith which gave a coefficient of .60 with pitch and .65 with tonal memory, most correlations summarised from 11 studies (Lundin, 1953) fall below .50.

As for the 1939 version, Manor (1950) found that fourth grade work in instrumental music could be forecast by the pitch test with a correlation coefficient of .49 and by the tonal memory test with a correlation value of .32. Wing (Buros 1953, p.344) compared the total score of 13 highly selected advanced music course students with estimates of music lecturers. The validity coefficient of .40 was "certainly more satisfactory than the results I obtained with the earlier form".

In view of the wide-spread use of the Seashore measures and of the doubts cast on their validity, McLeish (1950) undertook a validation study by factorial methods. He tested 100 students with the 1919 version, with the Wing battery and with the Oregon Musical Discrimination Test (see below). He came to the conclusion that the measures were "adequate for their original purpose, to measure the most elementary abilities required for the understanding and appreciation of music". Comparing the Seashore and Wing batteries he concluded "that Wing's tests measure much the same kind of ability as Seashore's but measure it at a higher or at least a different level, namely, that of musical meaning". The measures, McLeish added, will be "most effective if the scores are weighted in accordance with the calculated regression coefficients and if used in conjunction with other tests of musical appreciation". He emphasised, however, the need for further validation studies (Buros, 1953, p.343).

Since the tests seem to measure rather specific abilities, Lundin (1958) suggested we should "find the specific performances where these abilities are most needed before we discard the Seashore tests as being useless measures of musical talent".

One advantage of the Seashore measures over other music tests is that performance might be expected to be less affected by opportunities to hear good music, except in so far as the subject had acquired the habit of listening attentively to auditory stimuli. Scores can often be improved by special coaching (see Chapter VIII below), but in practice the individual is normally unlikely to have received such training. Seashore's own view is that maximum physiological development of sensory capacities is attained at an early age. Any apparent accrement thereafter (as allowed for in the Seashore norms) is to be interpreted as being due merely to the elimination of "disturbing factors", such as lack of concentration, or misunderstanding the instructions. Evidence claimed to support the view that instrumental lessons do not improve performance of the Measures, except by lessening the "cognitive" factors, was put forward by Stanton and Koerth (1930, 1933). Four groups of students were tested on entrance to the Eastman School of Music and again three years later. In the case of the fourth group - 157 students majoring in music - the improvement was negligible, since they were considered to have already reached their physiological limit by the time of the first testing. Wyatt (1945) in a critical study of the improvability of pitch discrimination pointed out that if students who left before three years had been included, i.e. the less successful ones, a greater increase might have been found. She also showed that the small average increase for the younger third group (152 special students) was partly due to the lower retest scores for the highest quartile. The third quartile - where there was more headroom for improvement - increased their scores by 5.6. Group I (285 preadolescents) and Group II (208 adolescents) in the Preparatory Department of the School had increased their mean scores significantly. These improvements were interpreted by Stanton and Koeth as being due to the progressive lessening with maturation of "cognitive" obstacles. However, in the absence of a control group whose scores had improved by maturation without training, this interpretation is at least questionable. Wyatt pointed out that 35% of Group 1 and 20% of Groups 2 and 3 had gained 7 points or more and, thereby increased their P.R. from e.g. 50 to 90. However, it is equally true that the scores of 57% of the youngest group (i.e. those most likely to improve) had not varied by more than 4 to 6 points.

Seashore and Mount (1918) reported low correlations (up to .31) between musical training, as carefully estimated from questionnaires, and pitch discrimination for large groups of college students. Brennan (1926) found significant correlations (.42 for pitch, and .55 tonal memory) between the tests and the number of half-hour lessons her subjects (20 music students) had had. She did not, however, claim that the training had necessarily caused the high correlations, for the student who possesses a keen tonal memory may naturally gravitate towards thinking and working with tones. Using a similar criterion of training, De Graff (1924 cited Farnsworth, 1928) found correlations between it and rhythm discrimination of .09 with 464 adults, of .10 with 282 eighth grade pupils and of .21 with 272 fifth grade pupils.

Even if the Seashore Measures were in fact less affected by past experience with music than tests based on musical material, the difference would probably be a reflection of their lower relevance to functional musical talent. Seashore and Mount (1918) reported low correlations (ranging from .14 to .34) between pitch discrimination and elementary musical tasks such as singing intervals and scales. While agreeing that musical subjects would prefer tests based on musical material, McLeish (Buros, 1953) considered the Seashore Measures more acceptable to the musically unsophisticated. In forming this opinion McLeish may have been influenced by his experience of the Seashore and the Wing (see below) batteries with University students. As students of psychology they may have found Seashore's tests of interest from the point of view of psychometric methods. Children who dislike music, or care only for dance music, might prefer the Seashore. However, even for 'dragnet' surveys, if the purpose is to discover talent worthy of special training, it would seem much better to use tests likely to appeal to those with some liking for music. For research into sensory capacities, the Seashore measures may be of value. The pitch test has been found useful outside the field of music (Anastasi, 1961, p.374).

Seashore with his co-workers at Iowa developed several instruments for assessing motor control in musical performance, and a seven point rating scale to be included in every battery for the measurement of musical talent as an index of vividness of auditory imagery. He himself recognised that the Measures represented "but one of the tools in a system of adequate guidance" which should include an audition and an intelligence test.

In spite of the criticisms levelled at the Measures and the development of rival batteries, Pinkerton (1963) found that they were being used for the selection of students for instrumental training in more U.S.A. schools (19 out of 70) than any other standardised musical aptitude test.

Kwalwasser-Dykema Music Tests

Kwalwasser and Dykema published in 1930 a set of tests which attempt to use musical notes on the same lines as Seashore uses sensory material. Like Seashore's, the K.D. battery contains measures of pitch, intensity, time, rhythm, timbre and tonal memory. To these, four tests have been added: a) of tonal movement where the subject is required to say if the last note of a melody should be higher or lower than the last tone given in the recorded melody; b) of melodic taste where the subject has to judge which of two final phrases makes the more appropriate ending to a two-phrased melody; c) of pitch imagery and d) of rhythmic imagery. The listeners are asked to compare the tonal and rhythmic patterns presented on the record with the notation printed on the answer sheet.

Percentile norms are provided for each test and for total scores for three-grade intervals from grades 4 to 12. But the tests appear to contain rather too few discriminating around the middle of the range of difficulty (Anastasi, 1961).

The manual does not mention reliability or validity. Studies on the reliability of the tests indicate that being shorter, they are less reliable than the Seashore battery. (Farnsworth (1931), however, reported that the corresponding tests in the two batteries do not appear to measure the same variables, except for tonal memory.) The tonal movement and tonal memory tests have usually yielded better reliability coefficients than the rest of the subtests, judging by the six investigations summarised by Lundin. The coefficients for these two tests are reproduced on the following page.

Table 2. Reliability Coefficients for the K-D Tonal Movement and Tonal Memory Tests (after Lundin, 1953, p.212)

Investigator	Method	Tonal Movement	Tonal Memory
Farnsworth (1934)	Retest Split-Half	.55 .85	.73 .63
Sanderson (1933)	Retest Retest	.37 .38	.43 .53
Manzer & Morowitz (1935)	Retest	.69	.73
Whitley (1932)	Split-Half	.67	.46
Drake (1933)	Split-Half	.85 .73	.57 .55
Beinstock (1942)	Retest	not included	.52

In spite of the low reliabilities of most of the battery, it has proved so popular that Holmes (1954) thought it worthwhile to develop new directions together with a new set of weighted scoring keys and new norms. For example, while in the original instructions the subject was asked to record S for "same" or D for "different", Holmes required the listeners to write E for "equal" if the second playing was the same. If the subject noticed a difference, he was asked to write DH if he thought the altered note was higher, DL if lower. Holmes gave extra credit for a correct judgment of DH or DL. As a result of his revisions, Holmes obtained the following improved coefficients with 237 high school students, aged 15 to 18:

pitch	.72	intensity	.79	tonal movement	.88
rhythm	.71	timbre	.70	melodic taste	.43
time	.50	tonal memory	.73	total test	.91.

While Holmes' procedure has improved the reliability of the battery, its validity is still open to doubt. Lundin's table of validity studies reported by five different investigators shows 17 instances where a negative correlation was found between a subtest and the criterion and only four examples of validities of .40 or over and one of .59. The table includes the results of Beinstock's predictive study of 122 students enrolled in the High School of Music and Art in New York. She found intelligence measures predicted individual success in music courses better than the K-D tests. Taylor (1941) found the Pitch Imagery and K-D Tonal Memory tests the two outstanding subtests from both the K-D and Seashore batteries in an extensive investigation of the prognostic value of the two batteries at a Music College.

Kwalwasser (1955) refers to several researches which show that his tests have some validity:

Briggs (1938) used the tests on two groups of children, chosen by their class teachers as being the best or the worst at singing in tune. The 1088 members of the good group made a total average score of 184.4, compared with 168.0 for the poor group. In a similar study Lambert (1941) obtained an average of 181.61 from children selected by their teachers as the 5 best sight-readers in the class, while the average for the children who were designated the 5 worst sight-readers by their teachers was only 170.57. The average age of the good group was 11:1 and of the poor group 11:3. The total number of children who took part in the investigation was 1,024. Of the 103 who were best in their class the average score was 201.92, for the 103 who were worst in the class the score was 152.70. The mean K-D score for 225 music teachers and students was found by Lehman (1948, 1950) to be 228.48, compared with 202.41 earned by the same number of college students of similar IQ who had at one time learned an instrument but who had discontinued their musical training. This confirmed Kwalwasser's finding that Arts Students averaged 30 points less on the K-D tests than did Music Students.

Farnsworth (1958, p.242) sums up the differing results of validity studies of the K-D tests in the words: "Perhaps the modal forecast value for the battery as a whole would lie in the neighbourhood of .40, with that for the individual tests being considerably lower".

The average total score of some 4,200 children aged 10 to 19 was 11.25 points higher (out of 275) in the case of those who had received six months or more training (Kwalwasser, 1955). This was particularly true of the Tonal Memory, Tonal Movement, Rhythm Imagery and Pitch Discrimination tests. It is curious that Rhythm Imagery should be more affected than Pitch Imagery. Both tests are likely to be susceptible to training influences since they require a knowledge of notation. When a longer period of instruction was taken as the criterion of the "trained" group, the mean score increased still further. But Kwalwasser does not mention how the longer period of training affected the sub-tests.

Though the K-D tests have the advantage over the Seashore of using musical stimuli, they appear to be inferior both in reliability and in discriminatory power. Farnsworth (Buros, 1949, p.262) concluded, therefore, that the Seashore was so much better than the K-D battery "that music testers should use it exclusively in their attempts to screen out those unfortunates who will not achieve success in music without enormous effort". One might add that tests based on musical material can also be used to identify the ungifted.

The Kwalwasser Music Talent Tests

This battery, published in 1953, takes only 10 minutes. Form A consists of 50 three tone patterns which are repeated with variation in a) pitch, b) time, c) rhythm or d) loudness. The subject has to decide in which respect the second playing has been changed. Two sets of norms are provided, one for Junior High school children, the other for Senior High School and College groups. Form B with 40 easier items is for grades 4 to 6.

The tests were included by R. Bentley (1955) in a critical study of recently published tests. He matched 110 instrument-playing music students of a Californian High School with 110 non-instrument playing music students on a basis of sex, IQ, grade placement and socio-economic status. He tested both groups with the Kwalwasser tests, with those of Wing, of Whistler and Thorpe, and of Gaston (see below), and with the Farnum Music Notation Test.

The Kwalwasser Test Manual has been critised by Farnsworth (1958) for offering no reliability data. When asked by Bentley, Kwalwasser stated that a reliability coefficient of .75 had been obtained, and one of .87 when the test was repeated. Bentley's own results, however, showed a reliability of only .59 as calculated by the Kuder-Richardson formula.

As external criterion of validity, Kwalwasser refers to the average score (43 points) earned by 100 College students majoring in music as compared with the mean score of 37 for a large number of Arts students. Though the tests did prove valid by Bentley's own criteria (difference between the two groups, interest in music as measured by Gaston's inventory, and music grades), they were lower than the other tests investigated. The loudness and rhythm items proved too easy for his subjects. That the battery may be too easy to be very discriminating with older subjects is suggested by the fact that a Senior High school student scoring half marks earns only a P.R. of 2, according to Kwalwasser's norms. The correlation with intelligence may be higher than generally found for musical aptitude tests (see Chapter III, p.116)

In its present form, the battery appears to be too short to be reliable and too easy to be discriminating among older and more musical children. If a short test of musical aptitude is required it would seem better to use e.g. the first three Wing tests (see below). These take only about 12 minutes of playing time.

Some Early Tests Based on Musical Material.

Both Drake (1931) and Wing (1936 and 1941a) have discussed in detail the attempts of their predecessors to construct tests of musical ability based on musical material. Therefore, only the most important, or those to which reference is made in other chapters, are mentioned below.

As early as 1920 Revesz (1953) was recommending that the use of the Seashore measures should be supplemented by a battery of four tests of "acoustic-musical capacities": a) rhythmical sense, b) regional pitch (a kind of approximate absolute pitch, where the note is differentiated without the aid of the tone quality), c) analysis of harmonic intervals and d) ability to grasp and to sing a melodic line. For the "higher grade of musicality" Revesz describes four further tests: a) relative pitch (an interval was played, followed by the first note of an interval at a different pitch, the subject being required to sing the second note), b) harmony (the subject being required to sing the consistent notes of a chord played on the piano), c) ability to play familiar melodies from memory and d) singing the ending of an unfinished melody.

In his first experiment, Revesz tested 63 children aged 7 to 12 (Revesz, 1920), but he did not standardise his tests and in his book published in 1946, the original battery appears largely unchanged. His tests were not intended as group tests.

Franklin (1956) who examined various test batteries in order to find suitable items to include in a factor analysis of musical ability (see p. 78), considered Revesz's two rhythmic tests to be among his best and used them in a modified form, on 105 student teachers. His results largely verified Revesz's.

The use of musical material is "not an easy matter, since a passage of music involves numerous factors which, in general, are not readily isolated from one to another; so that the experimenter who would have his subjects attend to the variation of some one factor in a series of presented phrases is often at a loss how to obtain phrases in which the special factors to which special attention is to be given may be pointed out quite unambiguously". (Lowery, 1929). Lowery elsewhere (1952) relates that, when he first tried to formulate a cadence test on "giving the test to both children and adults, chaotic results were obtained in spite of careful efforts to ensure the subjects understood what was required". Cadence tests, as both Wing (1948) and Franklin (1956) have pointed out, are difficult to apply to subjects without musical training owing to the difficulty of describing the cadences and because, in any case, two chord cadences do present a certain ambiguity of key. Lowery also worked out a tone memory test which required the subject to recognise a theme after certain changes e.g. after transposition or diminution or augmentation, and a phrasing test which in fact involved memory to rather a high degree (Wing, 1948). The retest reliabilities obtained from testing 130 girls aged 12-14 were .75 and .71.

Mainwaring (1931) constructed tests on the eduction of pitch differences and rhythmic patterns, and of recall. For the pitch test, Mainwaring asked his subjects e.g. to write down which two out of three or four notes played were the same. To assess the subjects' "concept of high or low" he required them to state e.g. if a series of notes moved up or down. His rhythm tests were concerned with metric accent and ability to recognise duple, triple and quadruple time. To test recall Mainwaring required his subjects to listen to a tune and afterwards to answer questions about it. The reliabilities claimed by Mainwaring were .81 for pitch and .74 for rhythm among 34 boys, whose average age was 11½. The reliabilities reported by Fieldhouse (1937) for his somewhat younger subjects (see further, Chapter II) were .62 for rhythm and .77 for pitch.

None of the tests mentioned above was standardised, except those of Seashore and Kwalwasser. The Drake, Oregon and Wing tests, all of which have been standardised and recorded are described below in separate sections, followed by short accounts of some of the later tests.

The Drake Music Tests

Drake's original battery consisted of four tests: interval discrimination, retentivity, intuition, and musical memory. The first consisted of 80 items of paired pitch intervals, the subject being asked to judge if the second was greater or lesser than the first. In the retentivity test, the subject is required to remember a musical interval, a beat given by a metronome, and a three note sequence. He then has to judge whether each of several intervals is greater or less than the original one, whether a metronome beat is faster or slower than the original and whether a single note was the first, second or third note of the three note sequence. (This ingenious test, intended "as a test of absolute pitch or memory for isolated tones" (Drake, 1933) seems to offer scope for the development of some really difficult musical puzzles!). The intuition test contained 72 items, each consisting of two unharmonized phrases. The subject has to judge whether or not the second phrase makes a satisfactory answer to the first. Each item was supposed to test one of the "intuitions" for phrase balance, time balance or key centre. When Drake experimented with these four tests with four musical groups and one largely unmusical school group, he found that only the musical memory and interval discrimination tests gave significant coefficients in more than one group. He reported (1933) the following reliability coefficients, corrected for attenuation: for musical memory, .93 and .85; for interval discrimination, .74 and .43; for retentivity, .76 and .53. (The first figures refer to a group of 48 music students, aged 7 to 16, and the second to 178 unselected boys aged 11 to 15). Using as criterion teachers' rankings of students, he obtained the following validity coefficients: for musical memory, .67 and .54; for interval discrimination, .58 and .42; for retentivity, .54 and .38 and for intuition, .36 and .35.

As these preliminary results suggested that the musical memory test was the most promising, Drake concentrated on standardising that test and, in 1942, a recording was published. Two parallel forms are available and can be used to obtain a more reliable, combined score. Each form consists of 12 different melodies, each of which is played two to seven times, giving 54 items in all. During each repetition the subject must judge whether the melody is exactly the same as in the original playing, which is not repeated between each comparison, or whether the key, time, or notes has been altered.

Percentile norms are provided for every two year interval between the ages of 7 and 22 for non-music students (i.e. those with less than five years of musical training) and for every three year intervals between 11 and 23+ for music students. The norms were derived from a total of 5,894 cases.

In 1954, Drake published a rhythm test, which is in fact a test of whether or not the subject can keep a steady beat in his mind during a period of silence. This is, of course, an important ability for all types of musical performance. In the easier form of the test, the subject has to continue to count a beat during silence till told to stop. He then records the number reached, which is compared with the correct answer. The total score is obtained by adding up the differences. In the more difficult form of the test, he has to count against a distracting beat. This would correspond to the ability to play, for example, triplets against duplets. Very low correlations are reported between the musical memory and the rhythm tests, as might be expected.

The reliability of the tests is high especially for homogenous musical groups - mainly with coefficients of .80

to .90+. (However, E. Gordon (1961) reported some disturbingly large discrepancies between two testings of 20 subjects - see further, p. 257). The advantage of measuring only two kinds of performance is that the subtests can be longer, thus improving reliability. The memory test alone takes 25 minutes, as compared with the 12 minutes required for the first three Wing tests. On the other hand, Drake's battery lacks a specific pitch discrimination test, though he was formerly of the opinion (1939) that a pitch test should always be included in any music testing programme.

The validities reported by Drake (1957) vary between .31 and .91 with a median of .53 and are based on correlations with teachers' ratings on a seven point scale. The teachers were specially asked to estimate aptitude and to disregard length of musical training, age, intelligence, technical ability etc. The wide range of validity coefficients is perhaps partly explained by the relatively large number of groups to which they refer, viz. 14, totalling nearly 600 persons for the memory test (form A and B together), and 10 with a total of nearly 300 subjects for the rhythm test. Drake himself offers no explanation of the variations, beyond referring to possible inaccuracies of the raters. In some cases this may be a satisfactory reason. But when such divergent results are reported as the following, for similar groups of children or for children at the same school, it is hard for the potential test user to judge the true position:

220 subjects from All High School Bands, Akron, Ohio

School A	103	children	r = .50
B	47	"	r = .75
C	59	"	r = .39
D	11	"	p = .82

69 schoolchildren (grades 5 and 6)

Teacher A	n. 19	r = .32
B	n. 24	r = .51
C	n. 26	r = .77

The validity coefficients for the two forms of the rhythm test also show some differences in range, the more advanced form being slightly more valid.

Possibly, as with the Wing battery (see p. 42 below), the Drake tests are more valid for the older or more musical subjects. The best validities (.91 for memory and .83 for rhythm, form B) were obtained for 50 members of the Summer Program Orchestra (ages 8 to 16).

That the Drake Memory test has a high validity is suggested by Bentley's result (1955) with Gaston's melodic memory tests (see p.54 below). These were extremely discriminating between the two groups studied by Bentley and, if he had used the Drake, he might well have obtained similar results with it.

A less favourable conclusion is suggested by Lundin (1949), who compared scores made by music students for the music memory test with the criteria he had used to validate his own battery (see p. 52 below). He reported lower validities in every case for the Drake than for the total score of his own tests (not an altogether fair comparison):

	Melodic Dictation	Harmonic Dictation	Written Harmonization	General ability in theory	Performance	Total
Drake	.50	.45	.36	.42	.09	.47
Lundin	.70	.70	.43	.65	.51	.69

As might be expected the highest correlations for the Drake test are with the two dictation tests (searching tests of ability and knowledge, as Wing (1948) remarked). The correlations with performance is remarkably low.

Drake (1957) claims that his tests are measures of " pure aptitude " and that musical training as such has little influence on the scores. This may be truer in the case of the rhythm test (see p.175 below) than in the case of the memory test. Drake gives the following correlations between the memory test and number of years the pupils had had music lessons: n. 190 r = .37; n. 50 r = .35; and n. 160 r = .43. Though Drake terms these correlations "rather low", they are certainly not negligible. In fact, he provides separate norms for use with students who have had five or more years musical training. Examples of the differences between the two groups are:

P.R.	Score (number of errors) Non-Musical at 11 to 12 years	Musical at 11 to 13 years
25	77	66
50	70	54
75	58	44

P.R.	Score (number of errors) Non-Musical at 15 to 16 years	Musical at 14 to 16 years
25	70	54
50	61	44
75	52	38

These differences appear to be quite considerable. They may be partly due to the self-selection of good students tending to continue with their music lessons, while the untalented give up. However, since five years is an arbitrary division, many of the non-musical group must have had music lessons for less than five years and the differences are, therefore, all the more significant. It is, of course, an advantage that, where a test is known to be affected by training, definite information should be available to the user, so that due allowance for previous tuition can be made.

To sum up, the Drake memory test has succeeded in surviving for thirty years and in winning considerable approval. The rhythm test is the only standardised test available that specifically measures ability to keep in time.

Oregon Music Discrimination Test

In the earlier form of this test, devised by Hevner, the subjects had to consider four versions of each item and judge which was the original, and which had been distorted by mutilation of the rhythm, harmony or melody. This proved too difficult for general use. The present form of the test consists of 48 pairs, one of which is the original and one distorted. One point is given for detecting which version is correct and a second for judging in what way the other version has been altered. The two-version form was found to correspond very closely to the earlier version in reliability and validity (Hevner, 1931).

The test is more reliable with older subjects, split-half reliabilities of .63 and .78 being reported for junior and senior high school students respectively. A reliability of .86 was obtained with 126 college students. Hevner (1931) reported that the test had considerable discriminatory value in distinguishing between psychology students and advanced music students.

Though care was taken to select music which was not likely to be familiar to the ordinary person, a correlation as high as .64 with musical training was found for 126 college students. With advanced music students, however, scores were not related to training (Hevner, 1931). Where scores can be considered alongside reliable information on the students' previous experience of music, the Oregon test appears to give satisfactory results. Farnsworth (1958 and 196 in fact considered it the best of the formal auditory tests of taste so far developed. Lundin (1958) agreed with this opinion and regretted that the test was no longer commercially available.

The Wing Standardised Tests of Musical Intelligence

Wing first started to work in the field of music tests in 1933. After a thorough survey of such tests as were then available, he decided "to compile a comprehensive series of new tests, to assess their relative merits, and ... to select a short series of proved diagnostic value", (Wing, 1941a, p.6). There were 21 tests in the pilot survey (Wing, 1936, p.19) which were revised and later increased to 25 (Wing, 1941a, p.505). In addition to tests of a cognitive type, Wing sought to include tests of appreciation - "a fundamental quality that all musicians would desire to find in any person who claims to have an interest in the art", (Wing, 1941a, p.70).

The earlier tests were applied by the piano. Later 13 were selected and recorded on discs. The results were sufficiently satisfactory to encourage Wing to develop an even shorter form which would still satisfy the following criteria:

1. They should be acceptable in their basic principles to musicians;
2. They should not be unduly influenced by training or opportunity;
3. It is preferable that the battery should be comprehensive in its power to assess subjects of widely differing capacity;
4. They should cover a sufficiently wide sample of musical talents;
5. They should fulfil certain statistical criteria of reliability;

6. They should be suitable for repeated applications to the same subjects without any great loss of efficiency;

7. They should give a score which is easily evaluated on a standardised scale;

8. They should be economical in the time required for their application;

9. They should correlate well with an exterior criterion;

10. They should be of practical use in musical education;

11. They should be simple to apply.

After various modifications the seven most suitable tests were again recorded and then standardised. As can be seen from the answer sheet in Appendix 1, the first three tests deal with aural acuity and the last four with taste or preferance. When the disc version of 1948 was published short practice examples to be played before tests 1, 2 and 3, were added. In 1957 a tape recorded edition was issued. Not only was the recording improved, but, as a result of an item analysis of 100 answers sheets obtained by testing members of the National Youth Orchestra, any item which appeared at all doubtful was removed or modified. The number of items in tests 4 to 7 was reduced from 20 to 14. In 1961 Wing tested an instrumental group of highly gifted students at the Eastman School of Music. In the case of only 4 out of the 136 items was there an element of doubt. Special attention was given to these in a new tape recording published in 1962. The answer sheets have also been improved by revisions.

By 1941, the seven tests had been standardised on 3,373 children aged between 8 and 17, and on adults. Scores increased with age up to 17 and norms were published for each age in five broad groups. The groupings were obtained by dividing the distribution curves for each age into five appropriate sections. (A 10%, B 20%, C 40%, D 20% and E 10%). A formula for converting scores into "Musical Age" is provided; the user can then calculate a Musical Quotient. In answer to Bentley's criticism that percentile ranks were not provided, Wing stated that he has hesitated to do this as it might give teachers using the tests an appearance of a finer degree of accuracy than actually exists. However admirably realistic this attitude may seem, some users may feel that verbal warnings on the limits of confidence of the tests might be sufficient. After all, Wing has no objection to Musical Quotients being calculated; these, if unwisely used, also give the appearance of fine sub-divisions of talent. No doubt for purposes of predicting future instrumental performance - the primary aim of the tests - the broad grouping is sufficient.

With the recorded version of 13 tests, a retest reliability of .95 was found with 71 boys, aged 15. With the shorter version of seven tests, when tests 4 to 7 contained 20 items each, retest reliabilities of .915 for 41 boys and .910 for 65 boys, both groups being aged 15, were reported (Wing, 1948, p.57). As the correlation of the tests when reduced to 14 items with the full test was .96, Wing did not consider the shortened version much less efficient, (Wing, 1962). The undoubted fall in efficiency was considered worth the time saved, as even psychologists do not use the tests fully if they are too long. The reliability claimed for tests 1 to 3 used alone is .89, for the last four tests .84. The numbers concerned in his early report were certainly small by present day standards, as Bentley (1955) pointed out. However, later research has tended to verify the earlier results. A split-half reliability for the scores of 100 New Zealand music teachers was .90 (Wing, 1962). Bentley himself reported a reliability coefficient of .86, calculated by the Kuder-Richardson formula; this was the highest reliability found for any of the aptitude tests included by Bentley in his investigation.

Wing (1962) pointed out that reliability is a function of the group tested as well as of the test. Thus, the correlation obtained with 19 students who volunteered to be retested after two years was .88, but groups of "non-volunteers" gave lower figures, as did children retested after 4 months by Cleak (1958). Seven out of thirty-four retest results of Cleak showed differences of more than 10 marks. Three large differences may possibly have been due to illness or lack of concentration on the part of the boys concerned. McLeish (Buros, 1953) found split-half reliability coefficients of .90 for the full test and from .65 to .86 for the individual tests as a result of testing 100 adults.

Wing (1948, p.60) reported the following validity coefficients obtained by correlation with teachers' rankings: .64 with 45 girls, using an early form of the tests; .78 with 15 children; .82 with 45 boys; .90 with 6 adults and .77 with 19 adults.

Wing also investigated the relationship between his test results and ability to persevere with the playing of a musical instrument. This evidence is described by Bentley as "very conclusive". 333 boys aged 14 to 16 were divided into Above Average, Average and Below Average according to their test scores. Wing then found that 40% of those with below average, and 27% of those with average, ability, who had started to learn an instrument, had let their playing lapse, while only 2% of those of the above average group had ceased to play. A similar study of 718 adults showed that 83% of the below average group, 30% of the average group and only 9% of the highest ability group had given up playing. In both the National Youth Orchestra and the Eastman School of Music results, all except one fell into the 'A' grade. In the case of the latter, the man concerned gave up professional music.

Additional evidence of the validity of the Wing tests has come from three independent studies:

1. Following Mursell's remark "We must try our developed tests on individuals known to be conspicuously musical and those known to be conspicuously non-musical to try to discover where the most crucial and significant performances are located", Whittington (1957) used the Wing tests on 48 children, aged 13:11 to 18:6. One group was actively musical, had gained certificates for performance etc. The other group disliked, or were not interested in, music, did not play and came from unmusical homes. The C.R. of the differences between the Wing scores for the two groups amounted to 10.5. An item analysis showed that all of the tests differentiated between the groups to a highly significant degree, the best tests being 2, 3 and 7.

2. A test may be considered even more valid if it can discriminate not only between those with a marked degree of ability and the definitely unmusical, but also between the more and the less able members of a highly selected group. A survey of the selection of junior musicians for the Royal Marines School of Music was carried out by the Senior Psychologist's Department of the Admiralty with a view to reducing failure among those under training (Newton, 1959). The Wing battery was given to 223 junior musicians who were then graded into average, above average, and below average by their instructors. Positive and significant correlations were found between these categories and the test results.

An item analysis showed that in only nine out of 136 items did the confidence level fall below 95%. Tests 2, 3 and 5 seemed to be the most valid.

Though this evidence is important and confirms the results of other studies, certain reservations should be kept in mind: The grading was based on the instructors' ratings for only four weeks. Moreover, no account was apparently taken of differences between instructors, or between instruments. Whether a boy was graded average or above average might depend on how good he was at the particular side of musicianship considered important by his instructor. (Examples of widely varying validities based on the ratings of different teachers have already been mentioned in connection with Drake's tests on p. 38 above). The "Below Average" group seems to have been reliably rated, however, as 24 out of the 28 boys were in the Backward Music Classes at that time.

3. Bentley reported certain evidence on the validity of the Wing tests. Of all the tests included in Bentley's study, the Wing tests were the most discriminating between the instrument playing music group and the non-instrument playing group (many of whom had had lessons), and correlated almost perfectly with the total score of all the music tests. Correlation with an index of interest in music was the higher than that of any other of the musical aptitude tests. The best single test for estimating the ability to perform

all the tests investigated was Wing's Memory Test. Wing's test 2 was the most effective single measure of pitch discrimination. Bentley concluded that where a very critical analysis of individual capacities is desired for guidance purposes, the Wing battery is the best test to use. When only a short testing time is available, the first three Wing tests are the most satisfactory.

In support of his claim that the test results are not largely affected by instrumental training, Wing (1941a, p.339) reported finding no significant difference between the percentages of instrumentalists among the above average, average and below average ability levels of 271 children. The children, however, were only 12 years old; some may have been learning for too short a time for training to have had its full effect. Wing claims that with older children the effect commented on cannot be seen as it is obscured by the fact that self-selection takes place i.e. the poor instrumentalists give up and those who are gifted will become self-taught if no lessons are available (Cf. Chapter VIII, p. 259). Wing (1941a, p.346) also found that the correlations of the scores of several groups tested after one to five years were high (.77 to .95) and unaffected by the fact that many had continued studying an instrument, a few had commenced and others had given up playing. Wing's evidence on the effects of hearing music in the home will be discussed in a later chapter.

Newton (1959) supported Wing's claim in reporting on the effect of musical training on the test results. As the junior musicians were undergoing a formal system of organised tuition, it was thought that the amount of their musical experience could be directly related to length of time under training. (Data on their musical experience prior to entry were excluded from statistical assessment as too unreliable). No significant difference was found between the mean Wing scores of boys classified as having 3 or less, 4 to 6, or 7 to 15 terms of instruction.

On the other hand, Whittington (1957) in his original report was inclined to attribute the differences between the musical and non-musical groups to the greater experience of the former. "Results seemed to indicate that the musical group was superior to the non-musical group because of musical experience, an experience which accounted for some 44% of the performance". The subjects he tested and later excluded from the non-musical group because they had learned an instrument or had some form of music in their homes made scores a little higher than his completely non-musical group. Later, however, Whittington somewhat modified his views and agreed in 1961 with Wing "that the relation between musical experience and test results is not that the experience caused the high results but that both spring from high musical intelligence".

In practice, the Wing tests do appear to have been found useful, for example, in selecting the right type of pupil for instrumental training. Thus, Waldon-Mills in a New Zealand Department of Education Bulletin reported that "the results" of using Wing's tests "have been most accurate especially as a pointer to instrumental ability". He had some experience of using the Seashore and K-D batteries and preferred Wing's. Wing can also quote reports from Aberdeen, Australia and Poland which speak of the success of his tests in selecting children for instrumental training (Wing - private communication). Jacobs (1960) summed up the position when he described the Wing tests as "well-founded and of great diagnostic value".

Points arising from the writer's own use of the Wing tests will be found in Chapters IX, X and XI below.

Lundin's Musical Ability Tests

Lundin's aim was to measure in an objective fashion those aspects of music commonly taught in musical theory courses i.e. ear training, harmony and dictation. Unlike most other authors of musical ability tests, he does not purport to measure innate aptitude. (As will be seen in Chapter VII below, Lundin believes that musical talent is largely the result of previously acquired skills and not inherited capacities).

The battery contains five tests. The first is a test of interval discrimination. For each of the 50 items the subject is asked to tell whether or not the second interval is the same as or different from the first. The second test, melodic transposition, consists of 30 pairs of simple melodies. The second playing is always in a different key from the first and may also contain one or more altered notes. The third test is called mode discrimination. Thirty pairs of chords are played. If both chords are either major or minor, the subjects responds with an "S", if one is major and the other minor, with a "D". He does not have to say if the chords are major or minor. The fourth test contains 30 items, each with 4 melodic patterns. The subject has to detect the cases where the fourth pattern has been changed. The fifth test is similar, but uses rhythmic patterns. (Lundim, 1953, pp.217-220).

Lundin reports the following reliability coefficients, computed by the split-half method, the first being for a musical group, the second for a group of unselected college students: interval discrimination .79, .71; melodic transposition .65, .71; mode discriminatiom .65, .10; melodic sequences .70, .77; rhythmic sequences .60, .72; total scores .89, .85. Lundin recommends the use of the mode discrimination test only with subjects with previous musical training, owing to the low reliability of the test with his unselected group - for which he offers no explanation.

The tests were validated against criteria of six different ratings by professors for the music group alone, (see p. 38 above). A very significant difference was found between the means of the music students n = 60 and those of the unselected groups n = 100 for each test and for total scores. There were no significant differences for the music group subdivided into two. The tests thus appear to discriminate well between the musical and unmusical. But, to use the battery to predict success in future music training, it would be necessary to assess how much was contributed to the results by previous musical experience. The tests themselves do not appear to be very different from others which, their authors claim, test innate aptitude.

Other Standardised Tests

Whistler and Thorpe Musical Aptitude Test

A piano version of this battery was published in 1950, but so far no recording is available.

The compilers stress the use of musical material rather than "mechanical devices". The battery consists of five tests: rhythm recognition, pitch recognition, melody recognition, pitch discrimination and a more advanced test of rhythmic recognition. The subject is required to state if the second playing of a rhythmic or melodic pattern is the same or different from the first. In the case of the pitch discrimination test, the instructions are similar to Wing's second test, i.e. if the listener decides the chords are different, he has to judge the direction of the change. For the pitch recognition test, a particular pitch is strongly emphasised. The subjects' task is then to count the number of times this pitch appears in a four-bar melody of 13 notes.

Decile norms are provided for the subtests grouped under rhythn, pitch and melody, and for the total scores. The reported reliabilities range from .64 for rhythm to .87 for the full battery. Bentley (1955) calculated a reliability coefficient of .745, but thought this lower figure might be due to differences in playing or to his experimental groups being more homogenous. The validity coefficients for 100 children, aged 11:8 to 13:3, varied between .21 (total score compared with experience of choir singing) to .78 (total compared with teachers' estimates of vocal talent). The total score correlation with estimates of instrumental talent was only .52. If these estimates were reliable, the tests would not appear to be too useful for selecting children for instrumental training, in spite of their face validity. Bentley found the easier part of the rhythm test and the pitch discrimination test too easy to be discriminating among his older subjects.

<u>Gaston - Test of Musicality</u>

The latest version of this test, issued in 1958, presented all the tonal items in one continuous record. The test aims at arriving at a general assessment of the subjects' musicality.

The test consists of 40 items, the first 18 of which are in the form of a questionnaire seeking to assess the subjects' interest in music. This leaves only 22 actual tonal test items. The first 5 of these deal with the ability to hear more than one part (subject has to find a given note in a chord), the next 5 involve a knowledge of musical notation (subject has to compare a melody of 4 to 8 bars with notation to check for a possible difference in time or pitch). These are followed by 5 phrases needing resolution up or down and by 7 short melodies, played twice, requiring the subject to state if the second version is the same as or different from the first. Separate norms are provided for the interest and tonal parts of the test and for boys and girls.

The reported split-half reliabilities are good: .88 to .90. Bentley (1955) obtained a coefficient of .84, which he considered satisfactory. He pointed out, however, that the validity evidence put forward by Gaston shows a significant association at a 5% level between teachers' ratings on a five-point scale and the scores only in the case of grades 10 to 12 and of 4 to 12. Items 19 to 33 proved too easy for Bentley's subjects, but the melodic memory items were, of all the tests investigated, most discriminating in distinguishing the instrument from the non-instrument playing group.

Graves (1947) found a significant difference in the Gaston scores of children who had received music lessons compared with a matched group who had not. She questioned whether the higher scores of the former were entirely due to their having greater natural aptitude (see further, p. 262 below).

Aliferis Music Achievement Test

This battery aims at assessing the subject's power of auditory visual discrimination, that is to say, ability to visualise the musical notation of what is heard and to hear inwardly what he sees. The tests require him to choose which musical notation out of four matches a melodic, harmonic or rhythmic element or idiom he has heard played. The 64 items are made up of 26 melodic, 18 harmonic and 20 rhythmic items. The melodic elements include all the intervals from a minor second to an octave.

The norms provided were based on testing 1,768 college students - the battery is intended to be used at college entrance level. The reliabilities calculated from 100 of the students by Hayt's method were: .84 for the melodic, .72 for the harmonic and .67 for the rhythm tests, and .88 for the complete battery.

Aliferis and Stecklein (1955) claimed these validity coefficients correlations with Music Honor Points gained by the students: .54 (melodic test), .41 (harmonic), .46 (rhythmic) and .61 for the total scores. Wing (Buros, 1959, pp.377-8) in a review of the test suggested these claims may be too modest.

Though the battery is called an Achievement Test it certainly measures much more than a knowledge of musical notation and theory. Having found a correlation of .73 with his own tests when used on 31 college students, Wing considered this would appear to indicate that the test was highly saturated with a general musical factor and might well prove to be a sound diagnostic test of general musical aptitude at college level. Aliferis himself suggests that if it is to be used for predictive purposes, it should be supplemented by an audition, an intelligence test and the Seashore Measures. But as the battery is much less taxing on auditory memory span than, for example, Drake's memory test or the Wing tests 3 to 7, it might be more useful to supplement it with either of these, rather than the Seashore.

<u>Franklin's Test of Tonal Musical Talent (TMT)</u>

The basis of Franklin's research (1956) was that a melody ends on the tonic. If the subject can find this tone, he has thereby demonstrated his musical ability. Franklin, therefore, sought to construct a series of short melodies in two parts which would be interrupted immediately before the final tone, the subject then being required to complete the melody by singing the final note.

After some experience of using the test in its individual form, Franklin also constructed a group version. Examination of the test results showed that distribution curves were satisfactory with the exception of a certain discontinuity around the mean value and Franklin envisaged that new items would be substituted for some of the items. Though the music for the tests has been published in Franklin's thesis (1956) no recorded version is yet available.

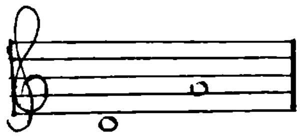
The retest reliability .820 and the split-half reliability .838 would seem very promising for a 15 minute test. The validity compared with a teachers' ranking was .51. These coefficients refer to the individual form of the test. The group test is considered by Franklin himself as "far from finished both with regard to reliability and validity", though usable to give some insight into the functioning of musical talent at a higher musical and psychological level. Faulds (1959), however, found the score of 35 unselected Princeton students averaged only little more than 1.5 points (out of 25) less than the mean score of 67 musical students from Westminster Choir. This may have been to some extent due to the sophisticated music students envisaging other acceptable endings and could perhaps have been avoided if the instructions had indicated that the required endings were in accordance with the idea that a tune should be expected to end on the tonic chord. However, the mean scores for both groups were considerably higher than for Franklin's Swedish students. The results of trying the test on younger groups are said to be "quite promising" (Franklin - private communication). The test may prove to be more discriminating with subjects below College level.

Bentley's Measures of Musical Ability

These four tests were primarily intended for younger children, aged 7 or 8 to 12 (Bentley, 1963).

A pilot test of pitch discrimination, based on a comparison of melodic intervals from a semitone up to a tenth proved too easy. A possible means of increasing the difficulty would have been to mask the pitch change by adding concurrent notes, as in Wing's test. Since, however, the harmonic aspect of music seemed to have little appeal to younger children (cf. Chapter IV, p. 157) and because artistic performance on pitch-variable instruments seemed to require subtle deviations from exact intonation comparable to *rubato*, Bentley decided to introduce smaller-than-semitone differences. In the present (fourth) version, the 20 items range from one semitone (26 c.p.s. difference at A = 440 c.p.s.) to 1 c.p.s. However, his results suggested that 3 c.p.s. was the smallest useful pitch difference that need be included in a group test. Bentley considers that his test would be improved by substituting differences of 4 and 5 c.p.s. for the present 2 and 1 c.p.s. items. The use of only the first 15 items might reduce the reliability less than would be expected, since most of his subjects guessed the answers to the last items.

The tonal memory test consists of 10 paired comparisons, each half of each item being a five-note tune. In the second playing one note is changed by either a tone or semitone. The subjects are required to state if the second playing is the same as the first, or if different, to state which note has been changed. The pitch range is restricted to



All the notes are the same length. The "five finger exercise" character of the "tunes" might seem rather monotonous to older subjects, but they were found quite acceptable by Bentley's subjects. Some even asked for more!

The chord analysis test is similar to Wing's test 1, though it contains a higher proportion of two-note chords, but no single note items, and the sounds are each sustained for three seconds at a level volume.

The rhythmic memory test is similar to the tonal one, with 10 paired comparisons of time patterns, played on one note, but with the pitch changed from item to item to avoid monotony. The separation of the tonal from the rhythmic aspect seems justified, since it makes the requirements of both tests less confusing for young children. Only with a 7 year old group did some of the children fail to understand the instructions.

For the pitch test specially calibrated sine-wave oscillators were used, for the others an electronic organ. The tests have been recorded on tape, but are not so far commercially available - the author himself is not wholly satisfied with the present version. Five grades, similar to Wing's, for ages 8 to 12, based on the results of testing 1,156 children are tabulated in Bentley's thesis.

Bentley obtained the following reliability coefficients from two testings of 90 children, mean age 10:9, four months apart: Full battery .84, pitch .74, tonal memory .53, chords .71 and rhythmic memory .57.

Bentley offers the following evidence of the validity of his tests: A significant association at the 1% level was found between test scores for an early version and class-teachers' estimates of the musical ability of 314 children; progress after 3 months violin tuition was significantly associated at the 2% level with the scores of 116 children, and after 15 months tuition at the 5% level for 65 children. Four groups known to be highly musical (34 University music graduates, 18 choral scholars, 38 talented children from a County Junior Music School and a group of violin teachers) all made high scores. Out of 26 boys seeking choral scholarships 3 out of the 4 who scored the highest marks were selected. (The boy with the highest mark was rejected because of his voice). On a second occasion the 4 (out of 22) selected were among the nine placed highest by the tests. In 1963, the boy chosen out of 15 applicants for one place had scored the highest marks on Bentley's tests (Bentley - private communication). When the scores of 100 children with an average age of 12:9 on Wing tests 1 to 3 were correlated with version I of the Bentley measures, the rho obtained was .82.

Judging by the results so far achieved, Bentley seems to be well on the way to producing a very useful and successful battery of standardised tests particularly suitable for younger children.

Conclusions

The choice of a test depends, of course, on the purpose for which it is required.

For most purposes, particularly for predicting success with an instrument, the Wing tests appear to be still unrivalled. They cover a wide sample of useful abilities; are of high validity and reliability for tests of an aesthetic nature and are relatively uninfluenced by previous training.

If a shorter test is required, the first three Wing tests give very satisfactory results. The battery then lacks any measure of rhythm. Where necessary, the fourth Wing test or his early time pattern test could be included, or the first three could be supplemented by Drake's rhythm test, if ability to keep a steady beat was thought important. (This would require the use of a record player as well as of a tape recorder, as the Drake test is not available on tape).

Drake's test of musical memory also appears to have high reliability and validity.

If a measure of capacity to discriminate between minute differences of pitch were required, the Seashore measure of pitch would be the test to use.

CHAPTER II

THE NATURE OF MUSICAL ABILITY

Introduction

In this chapter an attempt has been made to summarise briefly the intercorrelation and factor analysis data for different types of musical ability tests. These data, if discussed bearing in mind what is known of the relative validities of the tests concerned, provide some evidence on the nature of musical ability. For example, how far can it be considered unitary, or how far does it consist of independently varying factors not all necessarily inherited to the same degree? Is there some distinction between sensory and "higher" levels of musical ability? How important is musical memory? Can some abilities be regarded as "basic" i.e. preconditions of the development of others?

How far the abilities concerned can be affected by training is a question left for discussion in Chapter VIII.

As the inheritance of the exceptional ability of the great composers and performers has been the subject of several previous studies (see Chapter VII), this chapter concludes with a brief discussion of creative and executive talents, and of the aesthetic appreciation of music.

Theories on the Nature of Musical Ability

While the nature of musical ability is generally admitted to be complex, opinions differ on the extent to which its various aspects intercorrelate consistently.

Seashore's tests would seem to be constructed on a basic philosophy that musical ability may be divided into a number of sharply defined talents which are unrelated and could be present or absent in varying degrees. The tests correspond to the physical properties of sound: pitch, time, intensity and timbre. He claimed that such capacities are as basic to musical aptitude as they are to sound itself. Moreover, "each one of these capacities runs as an independent branch, not only in sensation, but through memory, imagination, thought, feeling and action", (Seashore, 1938).

In contrast to this theory of specifics, Mursell set forth an "omnibus" theory. "Music", he believed, "depends upon our perception of the dynamic relatedness of tone" (1937). He did not consider, as did Seashore, that musical ability depended directly on sensory capacities, but he agreed that the psychological capacities, upon which musical behaviour depends, are found in various degrees in widely differing combinations. As an example of an individual capacity which alone might not make a musician, he quotes rhythm, in the case of a jazz drummer who might be rhythmically effective but tonally inept.

It is, of course, true that most individuals find some aspects of music easier than others, e.g. a violinist may have good intonation but have difficulty in playing in time, or a pianist may play rhythmically and with good phrasing and dynamics but find his pitch discrimination insensitive when he attempts to deal with stringed instruments e.g. in conducting an orchestra. Rhythmic* skills such as writing from dictation a tapped time-pattern may frequently be present in those with little general musical ability (Wing, 1948, p.19). Fry (1948) found that tone deaf subjects were often able to recognise a tune by its rhythm. Bentley (1963) reported no significant inferiority among "monotones" at performing his rhythmic memory test. Among normal children the rhythm test showed no significant association with the other tests in one study. However, in another it correlated .25 with pitch, .34 with tonal memory and .40 with chord analysis. Bentley claimed that all the functions measured by his tests, though they may overlap and usually seem to be working together are in fact separate (p.145). This may be especially true of younger children (cf. Chapter IV). However, the various aspects of music, harmony, melody, rhythm etc. are so intimately connected in a composition

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*Wing (1948, p.19) recommends Cyril Winn's suggestion of using Rhythm for the onward flow of the music and rhythm (spelt with 'r') in the sense of time patterns.

that a reasonable minimum level of all-round efficiency seems likely to be required both for playing and listening. In fact, Mursell's jazz drummer hardly qualified to be called a musician. Actually the young orchestral drummers who were included in Wing's groups scored high marks on his tests.

Intercorrelation of Music Tests

Empirical evidence on the nature of musical ability is available from matrices of the intercorrelations between the subtests of various batteries, and of factorial studies.

Some general picture of the extent of the intercorrelation of various music tests can be seen from table III, (see p.68). The range of correlations will, of course, be affected by the tests used. For example, a test of harmony is likely to correlate highly with one on cadences or discords. On the other hand the diversity of tests subsumed under the name of "rhythm" can be judged from the following examples:

a) Bentley (1955) found little relationship between any of the rhythm tests included in his investigations except between the simpler and more advanced forms of the Whistler-Thorpe rhythmic recognition test. Ability to discriminate small differences of time appeared to be related to ability to discriminate small differences of rhythmic pattern, but not to the other musical measures nor to Wing's Rhythm test;

b) The correlations given by Drake (1957) for his own with Seashore's rhythm tests are very low viz. .11, .02 and .10

Table III. Range of Music Test Intercorrelations

(excluding correlations with the intelligence tests included in some of the studies)

Investigator	Tests Used	Range of Intercorrelations Less than .10	.10-.29	.30 and over	Total
Seashore; Brown; Mursell; Ruch and Stoddart*	Seashore	7	17	20	44
Manzer & Marowitz(1935)	K-D	20	22	3	45
Drake (1939)	Detailed below	-	13	15	28
Wing (1941a)	Wing Shorter Series of 7	4	3	14	21
	Wing Longer Series of 12	2	15	61	78
Whittington (1957)	Wing	4	15	23	42
Franklin (1956)	Detailed below	15	67	75	157
Faulds (1959)	Detailed below	9	31	51	91
Bentley (1955)	Wing, Whistler-Thorpe, Gaston	6	68	46	120
Lundin (1949)	Lundin	-	4	16	20

*As tabulated by Fieldhouse (1937)

c) Wing's hythm test and those used by Franklin (see p. 78) do not correlate highly. The coefficients were: with Revesz-Franklin (without music) .28, with Revesz Franklin (with music) .16, with Franklin's drummed rhythm .049 and with Franklin's melodic rhythm .179.

d) The correlation of Seashore's rhythm test and Lundin's was only .20 (Lundin, 1949).

The range of correlations may also be affected by how well they suit the group tested. For example, if they are difficult for the age range tested, the correlations are, in general, likely to fall. They may be higher among musical, than among unselected subjects (cf. Lundin, 1949).

The intercorrelations tend to be higher for tests based on musical material. However, positive correlations are usually found among the subtests of the Seashore and K-D measures and between these and corresponding tests based on musical material. For example, Seashore's pitch test correlates .53 with Wing's test of pitch change in Fauld's results and .49 and .40 in Franklin's. Seashore's Memory test gives correlations of .56 (Lundin, 1958) and of .21 with Drake's (Drake, 1939), and of .64 and .75 with Wing's (Franklin, 1955).

Part of the correlation shown among the tests in table III may be due to general intelligence (not partialled out). However, discussion of this point will be deferred, since the factorial studies briefly outlined below may throw a little more light on the matter.

The Factor Analyses of Drake and of Karlin

For his factor analysis Drake (1939) chose 8 tests which his investigations had shown to have reliabilities over .30. These were: his own musical memory and retentivity tests; the Seashore measures of pitch, time, rhythm, intensity and tonal memory, and the K-D tonal movement test. His subjects were 163 boys, averaging 13 years old and musically unselected. Spearman's tetrad-difference technique was used.

In addition to specific factors, Drake, after partialling out age, intelligence and training, found a common factor with over 30% variance and five additional groups factors between: tonal memory and tonal movement, pitch and intensity, pitch and tonal movement, musical memory and tonal memory, and intensity and time. The overlaps between the two memory tests and between pitch and tonal movement (the latter depending on pitch discrimination in a musical situation) are not hard to understand. As for the connection between tonal memory and tonal movement, Drake (1931) reported that many subjects could score well on the former, but not on the latter (which involves judging the direction of the satisfactory ending to a sequence of four notes). He concluded that the judgment required by the tonal movement test was entirely different from, but dependent on, memory.

Karlin (1941) re-analysed Drake's data, using the centroid method, to give three factors. The first, a general factor (unrotated), had high loadings in musical memory (.54) and in pitch (.69) and the lowest in rhythm (.486). Before interpreting his results, however, Karlin rotated the factors to give: (1) a memory factor with significant loadings in musical memory, retentivity and rhythm, and lesser loadings in the Seashore measures of time and tonal memory, (2) a retentivity factor with loadings particularly in tonal movement, tonal memory and retentivity and (3) a tonal sensitivity factor concerned with pitch, intensity and tonal memory. Thus interpreted, Drake's data conformed to the results of Karlin's own analysis.

Karlin himself used the Drake memory and retentivity tests and eight other auditory tests mostly adapted from Seashore (whose battery was considered too difficult in its original form for the 120 undergraduate subjects). The results were factorized by the centroid method. Again, before rotation, Karlin obtained a factor with positive loadings in all the tests except intensity (around zero). The highest loading was in musical memory (.732), while tonal memory had a comparatively low loading of .311. Interval discrimination, time and retentivity had high values in this factor. A bipolar factor contrasted the retentivity tests with musical memory. In another bipolar factor memory, retentivity and rhythm were contrasted with interval discrimination, pitch and time.

After rotation, Karlin interpreted one factor as being of Tonal Sensitivity (with most weight in the pitch and interval tests), one as memory for form (Drake's memory test having the highest loading .561) and the third factor as memory for elements, with the highest loading in retentivity (.49) and subsidiary loadings of .39 in rhythm and .29 in musical memory.

Karlin thus believes that there is evidence for two types of auditory memory. The connection between Drake's memory test and memory for musical form seems reasonable. Memory for smaller units seems a reasonable description of the ability required for the retentivity test. How important such a distinction might be in listening to or playing music is another matter.

Karlin (1942) then turned his attention to an extensive investigation of auditory and certain visual variables. The results of testing 200 high school children with 32 tests were factorized by the centroid method and nine factors obtained. Vernon (1950) pointed out that, though Karlin claimed auditory abilities yield no general factor, most of his correlations were positive. Before rotation, his first factor carrying 15% of the variance had positive loadings in every test, ranging from .78 pitch discrimination of short sounds to .14 for loudness discrimination. However, Vernon would agree that group factors are more prominent than general auditory ability in Karlin's very miscellaneous battery. The group factors of pitch discrimination, loudness discrimination etc. have in any case rather limited interest from the point of view of the psychology of music, since the tests did not involve music as such, but were on the sensory level.

Fieldhouse's Factor Analysis

An early factorial study of musical abilities worth mentioning is that by Fieldhouse (1937). His purpose was to investigate causes of singing out of tune. He tested 50 schoolchildren, aged between 9 and 11, who were selected by their teachers as unable to sing in tune, who scored 5 or less at some simple "ear tests" and who sang two songs of their own choosing off pitch; and compared the results with a control group of 96 "normal" boys. The tests used were the Seashore battery and Mainwaring's tests of pitch and rhythm. The means of the Mainwaring and Seashore pitch tests showed that the special group was only just significantly different from the control group (C.R. = 3.03 and 3.06). The C.R. for the memory test was, however, 4.68. The scores from each group were factorized separately. A factor concerned with memory was identified for the normal group, but was absent among the experimental group. Fieldhouse therefore concluded that singing out of tune was more due to lack of musical memory than to defective pitch discrimination, as measured by the Seashore and the Mainwaring tests.

In the case of both groups, Fieldhouse found a first general factor among the music tests, a test of vocal range and of intelligence, only auditory acuity having a negative loading.

Wing's Factorial Studies

Wing's first factorial analysis was based on the results of testing a group of boys, aged 11 to 13, with 9 of the tests he was then (1936) developing. Besides the tests which are numbered 1, 4 and 7 in the present battery, the tests included were concerned with discords, note present or not in chord, notation reading, intervals, which notes move and melody dictation. Five factors were extracted by Thurstone's method. The first appeared to be a general factor which had loadings ranging from .396 (discords) to .779 (intervals). The second, with strong positive loadings on Test 1 and Melody Dictation and negative loadings for Notation Reading, Discords, Rhythm and Phrasing was tentatively interpreted as "the power to analyze the relations between the musical stimuli". The third factor, Wing suggested, might be concerned with "the power to retain an auditory image of certain notes or combinations of notes". The notation test had the highest loading. Wing (1941a, p.265) found that most subjects attempted to read the notation given and check the sounds presen in auditory imagery with the music played. Wing then went on to consider the fourth factor. (In later analyses Wing (1941a, p.299) considered that the first three factors are as much as can be usefully interpreted). The tests which gave a high value for the fourth factor involved an 'impression' or 'feeling', rather than any explicit cognitive act. This appears reasonable in the case of the Discords test (loading .299) and the Rhythm test (.190), though questionable in the case of Melody Dictation (.219). The fifth factor had weak loadings in the Melody Dictation and Discords tests and Wing thought this might possibly be a notational factor. The rest of the tests had zero or negative loadings - which Wing took as tending to confirm that they were uninfluenced by the subjects' acquired musical knowledge.

In 1941, Wing factorized the results of testing 43 boys aged 14 to 16 with the seven tests of his final battery. To increase realibility the scores obtained by testing the boys twice were combined. Again a general factor was found, amounting to 40.8% of the variance. The Phrasing test had the highest loading .765, and the Rhythm test, the lowest, .421, as calculated by Burt's weighted summation method. Re-analysis by Hotelling's method of principal components gave similar results. A bipolar factor accounting for 13.4% of the variance divided the tests and the persons tested into two main types, suggested as possibly analytic and synthetic respectively. A third factor had positive loadings only in tests 1 and 5 and was regarded as distinguishing those persons who have a better appreciation for harmony than for melodic or rhythmic line.

The analysis of a third group using 13 of the earlier forms of the tests, also provided evidence of a general factor and of a bipolar factor dividing the tests into those depending on "perceiving" and those depending on "judgment" (Wing, 1941a, p.307). Wing can, therefore, claim that, while the factor pattern must change with changing tests and groups, the general overall pattern of his results shows considerable similarity - especially in the recurrence of a general factor which does not seem attributable to 'g'.

Faulds's Factor Analysis

Faulds (1959) rotated Wing's factor matrix to simple structure and confirmed a factor (Y) separating the tests depending on listening to notes sounded simultaneously from the rest of the battery, and a factor (Z) which was concerned with qualitative judgments. His factor X, however, appeared somewhat different from Wing's first factor. The memory test had the highest loading (.624) with the Pitch test second (.423). Tests 4 and 5 had zero loadings. Fauld concluded that factor X involved memory, presumably some kind of melodic memory. Memory doubtlessly plays an important role in the performance of the Wing tests - the correlation matrices of the writer's factor analyses show appreciable correlations between test 3 and the total of the battery (see Appendix). With younger children, some of whom were not particularly musical, memory would be likely to be rather highly involved in the last four tests. There is no fundamental conflict in Wing finding an unidentified general factor peculiar to music tests, and Faulds finding a factor X which he identifies as melodic memory. However, Wing's own treatment of his factor analysis in terms of a general musical factor would seem to give the truer picture.

Faulds's own investigation (1959) was an attempt to examine the sense of pitch in a variety of situations, some musical, some not, with the object of deciding the relations between these areas. He included Seashore's Measures of Pitch and Tonal Memory, Lundin's Interval and Wing's Pitch Tests, and Franklin's TMT Group test, along with a number of tests such as octaves and scales played flat, sharp or correctly. The 14 auditory tests and a test of auditory digit span were administered to 67 freshmen from Westminster Choir College and 35 freshmen from Princeton, i.e. to one group known to be musical and to another unselected as regards musical ability. The results were factorized by the method of Principal Axes and then rotated by Extended Vectors.

Faulds's investigation produced evidence of a general factor with Wing's test having the highest loading (.810) and memory for digits near zero. However, Faulds rotated this factor, taking as principal axis the test with the lowest value (.188), the TMT test. Theoretically, this test might have been expected to be highly saturated with a "musical" factor. However, in Faulds's results, it failed to discriminate effectively between the musical and unselected groups (cf. p. 58 above). After rotation, Lundin's interval test had a zero loading in the first factor and Wing's test one of only .237. This first factor was designated "Music" by Faulds, though since he had attempted to study Pitch and exclude as far as possible the influence e.g. of rhythm, a term such as "judicious pitch" might seem more appropriate. The other two factors obtained were considered quite reasonably to be concerned with pitch and memory.

Franklin's Factorial Studies

For his first analysis, Franklin (1956) used his own individual TMT test (see p. 57), his adaptions of the Revesz rhythm tests, Seashore's measure of pitch and tonal memory, the Wing battery and an intelligence test. The subjects were 79 Training College Students, the method that of successive approximation. For a longer study with 157 subjects, the Revesz tests were replaced by two original rhythmic tests, and a group form of the TMTtest was included. The results of retesting his subjects with the Seashore pitch test were used as a separate item, in order to discover if "elements lowering the cognitive limit" in the second testing "would be apparent in the factor patterns". While it might be useful to investigate the effects of retesting on performance of Seashore's tests, the inclusion of the same test twice unfortunately will reduce the value of the analysis since the first factor axis will come out so that it runs through the repeated test. Four non-musical tests were included in the second analysis, one of intelligence, one of vocabulary and two of visual perception.

In both analyses, general factors were obtained before rotation. The large common factor in the first analysis had high loadings for Seashore's memory test (.75), for Wing's pitch and memory tests (.71 and .68) and for the Revesz tests. The loading for the intelligence test was low (.14), as might be expected. In the longer series of tests, the two memory tests had high loadings, closely followed by the repeated Seashore pitch test. The inclusion of four non-musical tests is likely to disturb the general pattern to a greater extent than only one. The size of the values for vocabulary (.41) and intelligence (.40) in the first factor is somewhat unexpected. However, the negative loadings in other factors of these four tests would tend to rotate the first axis away from any general musical factor.

Franklin himself rotated his factors before interpreting them. Four factors were obtained with the shorter series of tests. The significant loadings in factor I were, for pitch and memory, especially for Wing's tests. The highest loading in Factor II was received by the TMT test (.68). As significant loadings were also found for the memory tests and for Wing's pitch and harmony tests, Franklin concluded that TMT was "a higher musical talent function of a synthetizing nature". The Revesz-Franklin rhythm tests and the intelligence test had the most important loadings in factor III (see Chapter III below). Factor IV showed more or less significant loadings in the whole of the Wing battery, with the exception of the memory test.

Two of the nine factors obtained from the second analysis (Band D) had largely non-musical loadings (see further, Chapter III). Factor A was largely concerned with the repeated Seashore test, but Wing's pitch test also had a fair loading. Both memory tests had positive loadings in C. Factor E was largely concerned with rhythm, especially the drummed (non-melodic) rhythm test, Wing's Rhythm appreciation test having a zero loading. The largest loading in factor E was for Wing's Intensity test, with smaller indications of the Wing harmony and phrasing tests, the TMT group test and Franklin's melodic rhythm test. This F factor, along with the H factor, corresponded to Factor IV of the earlier analysis, H having a large loading in Wing's Phrasing test. Most of the melody, harmony and memory aspects of the previous (TMT) Factor II appeared to enter into Factor G. The final factor J had a strong loading for the TMT group test and a smaller one for the Intelligence test (see also Chapter III, below).

McLeish's Factor Analysis

McLeish's (1950) main purpose was to test the validity of the Seashore battery against other tests using musical material viz. the Wing and Oregon batteries. His subjects were 100 University students; he used Burt's factorizing methods.

The first factor was described as a general musical talent factor with decidedly higher loadings (45% of the variance) in the Wing battery than in the Seashore (29%). One bipolar factor was found in the case of the Seashore (10%) and two, with 10% and with 8% of the variance, in the case of the Wing. The specific factors amounted to 38% for Seashore's and 12% for Wing's battery. The Seashore bipolar factor divided the Memory with a positive loading of .31 and the Rhythm tests (loading .53) from the other measures which had negative loadings. McLeish interpreted this factor as dividing the tests that depend chiefly on immediate discrimination from those depending upon immediate memory.

Vernon's Factorial Study

Vernon (1950) gave 17 tests, including the Oregon Music Discrimination test and a musical knowledge questionnaire, to 70 students. The scores on the musical knowledge and the Oregon tests gave general musical factor loadings of .84, the Seashore memory test having a loading .65 in the same factor and the Seashore measures of pitch and rhythm .28 and .35 respectively. In addition, the three Seashore tests had a considerable group factor of their own.

Vernon concluded that there is a large common factor in tests involving perception, memory and judgment of musical materials, but that the more sensory type of test has little relation to this.

Burroughs and Morris's Factor Analysis

Burroughs and Morris (1962) asked 100 children aged 13+ at a Comprehensive school to sing back a 12 note phrase. The results of 8 trials were factorized with scores for the first 6 Wing tests, Mainwaring's memory test, an intelligence test and a measure of interest in music. The first factor after rotation was concerned with pitch, Wing tests 1 to 3, having high loadings; it was described as memory for melody and though it had high loadings for each trial, it showed a tendency to decline after the early trials. A second factor, recognition of musical shape, with high loadings in intensity and harmony, appeared to increase in importance in later trials, while an intelligence and interest factor declined after the early trials. Wing's Rhythm test had a loading of .51 in the fourth factor. Loadings for the criterion task built up from -.03 for trial 1 to .52 and .51 for trials 7 and 8. It is rather surprising that any appreciation of the rhythm of the task should evidently be lacking at first. Perhaps the children were accustomed to concentrating on the pitches when first learning new songs in the classroom.

It is apparent from the above that, in Drake's words (1939), "even when a special attempt is made to measure isolated and independent abilities it is seldom absolutely achieved". Such measures as the Seashore battery yield group factors, or even, in McLeish's study, a general factor of their own. This remains true even when general intelligence has been partialled out, so that is unlikely to be wholly attributable to e.g. ability to concentrate or to follow instructions, though it might be due to some kind of ability to attend specifically to auditory stimuli.

On the other hand, as might be expected, measures of sensory abilities do appear to be relatively more independent than tests based on musical material.

How far any common factor found by factorization is evidence of the unitariness of musical ability depends, of course, on how successfully the tests used covered all aspects of the ability.

In the case of Drake and Karlin (first analysis), Karlin was wise to realise that the tests involved by no means covered all aspects of musical ability, as most of them were concerned either with sensory capacities or some form of memory. Moreover, the validity of most of the tests was low. Vernon's more varied choice of tests, including the well validated Oregon Appreciation battery, was more likely to have revealed a common factor of wider significance.

In ing's case the comprehensiveness of his battery depends on how wide was his original choice of tests and how valid is his claim that "no vital test is missing from the short series" (Wing, 1948, p.49). The seven tests of the short series correlated very highly with thirteen wider ones. These in turn gave very high correlations with the original twenty four - as comprehensive a battery of music tests as have ever been used. Mainwaring (1947), however, expressed some doubt as to how well the short series covered the rhythmic aspect of music. He agreed that if a general factor of music could be regarded as having been established, the most valuable tests would be those most saturated with it, but on the other hand, if, as Mainwaring himself believed, musical ability consisted of a group of independent variables, then the weak association between a test and the total of a battery would be all the greater reason for its <u>inclusion</u> rather than its <u>exclusion</u>. (Mainwaring (1931) had found rather low correlations between his own rhythm test and his pitch test (.32 and .22) . This is hardly surprising, considering the nature of the tests.)

Wing had, however, found that rhythm dictation (from the lohger series) and Rhythm appreciation were two tests which were in the twelve highest intercorrelations (out of 171 intercorrelations of 18 tests). It therefore seemed reasonable to consider one redundant. The Rhythm appreciation was chosen as the one test of Rhythm to be included in the short series, because firstly, "the tasks set can be made extremely difficult without needing, or being noticeably influenced by, any acquired knowledge of musical technicalities. Secondly, it is closer to the appreciation required in listening to normal music. Finally, it can be applied repeatedly to the same people without deterioration in efficiency" (Wing, 1941a, p.143). Mainwaring (1948) agreed that as "a preferential judgment implies a preliminary perception of difference and, in this kind of judgment, the ability to differentiate between pattern and distortion, it seems reasonable to assume that the inclusion of one rhythm test ... is in this instance quite adequate".

Other types of time and rhythm tests do not seem to have been proved especially useful or valid. The validity of the time and rhythm tests of both Seashore and Kwalwasser-Dykema is low (see Chapter I). Neither Franklin nor Revesz provided validity coefficients for their rhythmic tests, but Revesz considered his test of "rhythmical sense has the lowest symptomatic rating" (Revesz, 1953). This may have been partly due to deficiencies of the test. Drake's test of steadiness of pulse would appear of practical usefulness and of reasonably high validity (see Chapter I). Whether such a test would add much of value to the Wing battery is doubtful. Certainly, if only one rhythm test could be included, Wing's would seem the most likely to be valuable, as the Rhythm is presented in a musical context. Holmstrom* has added a rhythm test in which the subject is asked to say

*Cf. p. 441.

whether some time patterns are the same or different, to a close copy of Wing tests 1 to 3. When his results are published, it will be interesting to see whether the reliability and validity are an improvement on the original.

A test which Wing was forced to omit "with regret", owing to the length of time it took was appreciation of the pace. A reviewer of Wing's tests suggested (Buros, 1953) that this item might have been shortened rather than discarded. However, even with only two choices of tempo, instead of three, or with the number of items reduced from 20 to 14, it would still have required nearly 30 minutes. In any case, a subject with a high score for appreciation of Rhythm, harmony, intensity and phrasing would seem very likely to be able to choose a suitable tempo for performance (within his technical capacities, but that is a different matter).

On the whole, then, though Wing had other criteria than the wide coverage of musical talents, it would seem true that his battery does not leave out any important aspect of musical ability. The common factor found in his factorial studies of 1936 and 1941 would seem to be good evidence of a general factor of musical ability*.

In addition to the general factor, Wing's third factor provides some evidence of a differentiation between the

*It might seem likely that the ability involved in actually listening to or performing music, as opposed to a testing situation, is more unitary still since for the purposes of the test, the subject is instructed to concentrate on one particular aspect of the music, e.g. the Rhythm or bass.

melodic and harmonic aspects of musical ability. Vernon (1950) also found the Harmony score for the Oregon test often differed from the rhythm and melody scores, while the correlations of the latter with other tests were almost identical. Wing found no evidence for a difference between rhythmic and melodic abilities, but states that this might be due to having included only one test of Rhythm. (To some extent Rhythm must be involved in his Phrasing, Harmony, Intensity and Memory tests). Vidor considered that melodic and rhythmic abilities may differentiate. This might be because a number of her subjects were younger children where differences are possibly more marked (see further, Chapter IV).

Interpretation of the Common Factor

In the complex process of listening to music or to an auditory test, there would seem to be four stages or levels at which variations between individuals could occur which might account for differences in musical ability. The attempt to distinguish these stages is not, of course, meant to imply that they may not be largely interdependent, but interpretations of musical factors may be discussed under these headings.

The first stage might be called the "attention" stage. Wing in his very tentative interpretation of the general factor of his first analysis calls attention to this stage. This general factor, he surmises (Wing, 1936) "might be the capacity to attend specifically to abstract auditory stimuli - as distinct from the capacity to attend, say, to concrete auditory stimuli such as spoken words". This is very similar to the "earmindedness", put forward by Drake as one possible explanation of his own common factor. What is implied is not only ability to concentrate on the task during the test, but rather a habitual tendency to learn through listening. Drake refers to the old suggestion that individuals can be divided into visual or audile types. Drake considers the evidence for this good, but not to be applied categorically. (One complication is that individuals with good auditory imagery in one respect e.g. speech do not always necessarily seem to apply it in musical situations). Willingness or ability to attend is closely connected with interest (though not wholly dependent on interest) and will be further discussed in Chapter VIII below.

The second stage might be the sensory level. This would appear to be the one stressed by Seashore, though his measures are obviously affected by the attention stage. Mere sensory proficiency would seem to have some importance in musical perception - after all, music is conveyed through the physical medium of sound. However, according to Wing's (1948) evidence based on testing 22 partially deaf boys, a degree of deafness up to a loss of 15 decibels did not appear to affect ability to do his tests. Even the Seashore tests do not appear to be very much affected by auditory acuity as measured by an audiometer, for Fieldhouse (1937) obtained slightly negative correlations between the measures and a test of auditory acuity. As Karlin (1942) pointed out, patients with the same auditory acuity differ appreciably in auditory abilities in more complex auditory situations. However, Tomatis (1953; 1953a) claimed that the musical ear is characterised by a progressive rise in acuity between 500 c.p.s. and 2,000 c.p.s. Further, it seemed important for musical perception that one ear (the right for right-handed persons) should be clearly dominant. (See further p.251 below.) The association between this type of audiogram for the dominant ear and musical talent seemed to occur among all 50 of a group of aircraft workers, as well as among professional singers. However, the musical talent was not verified by music ability tests.

The third level might be the "level of musical meaning" to use McLeish's words, when, for example, a succession of notes of different pitch are perceived as a tune or a Gestalt. (See Chapter V for further discussion of the Gestalt view of music). The importance of this level has been stressed by such psychologists as Vernon, Mursell and Wing.

Because recognition of musical meaning implies associating the stimuli with past perceptions, Seashore considered the Wing tests measured attainment rather than aptitude (Wing 1954). Although Wing admits the necessity of a reasonable minimum of past experience through which the aptitude may become overt, he uses the term musical "intelligence" with the express purpose of showing by analogy the kind of relationship which is likely to exist.

The contrast between levels two and three is particularly stressed by Franklin in his discussion of his factorial results. He regards the differences between the factor patterns for Wing's and Seashore's pitch tests as evidence of the need to "differentiate between mechanical-acoustic and judicious-musical pitch discrimination". Franklin considers that evidence on this difference is provided by the zero loading in factor II of Seashore's pitch test, where Wing's shows a significant positive loading. By mechanical-acoustic discrimination Franklin means the ability to discriminate between very minute pitch differences as in Seashore's test. Judicious musical differentiation, as required for Wing's test, is the ability to e.g. deal with pitch changes in a musical context. In the border region between the two he believes that there may be "an interplay between judicious and mechanical discrimination".

As physiological evidence tending to support this distinction between acoustical and judicious pitch discriminatio Franklin quotes Pavlov's report (1927) of experiments by Babkin: Three years after the removal of the posterior cerebral hemisphere, a dog could be trained to respond to a simple pitch, but was unable to discriminate between an upward moving scale and a downward moving one (a task within the powers of a normal dog).

In discussing McLeish's results, Franklin considers that judicious pitch provides a simple explanation of McLeish's general musical factor, pointing out the difference in significance in the loading (in McLeish's analysis) of the Seashore rhythm test and the loading (in Wing's analysis)* of the Wing Rhythmic test. In general, it is no doubt reasonable to expect that tests in which Rhythm is presented in an melodic and harmonic setting to show higher loadings in a general musical factor than a rhythm test based on clicks. One might add that Form B, the rather more valid form of Drake's rhythm test, also shows somewhat higher correlations with Drake's memory test than Form A. The coefficients are: .18 as opposed to -.05 for 190 high school children and .46 as opposed to .16 for 62 children. (Drake's memory test may measure a fairly wide area of musical ability, though not as wide a sample of musical talents as the Wing battery). Franklin also considers that the bipolar factor for the Seashore measures of McLeish's analysis can be more satisfactorily explained by contrasting acoustic with judicious talents, rather than immediate discrimination with immediate memory (McLeish's own interpretation). Certainly, the two Seashore tests with positive loadings, memory and

*McLeish did not present the tables for the Wing battery, so that Franklin referred to Wing's own factorial tables.

rhythm, are those which seem most meaningful to musicians (Wing, 1948). The Seashore rhythm test had a reasonably moderate loading in Vernon's Musical factor (.35 as compared with .28 for pitch, generally found to be more valid). However, the validity coefficients shown by Lundin's table (1953, p.208) range from -.15 to .47 (median .21). It has, too the lowest loading in McLeish's first general factor.

The fourth "stage" in the process of musical perception might well be musical memory. Drake actually suggested memory as an alternative explanation to "earmindedness" for his common factor. He thought there might be sufficient memory involved in keeping the first tone in mind in Seashore's Pitch and Intensity tests to make this interpretation possible. If this were true, "individual differences in retention in the auditory nerve could readily explain great differences in talent". Drake later in fact became associated with an "Integrative" theory of musical ability. While adhering closely to the Seashore theory of specific talents he thought that they might all depend on, or be knit together by, the factor of musical memory (Lundin, 1949).

In general, the importance of memory (both long-term recall and immediate memory) in musical ability is undeniable. Some examples of empirical evidence on this point are:

1) Of all the tests used by Bentley (1955) the Wing memory test gave the highest correlation with the total score. This is not surprising since many of the other tests depended

on memory - but the number of tests involving memory in the field of musical ability testing is in itself some indication of the importance attached to memory by test authors.

2) The high discriminatory power of the Gaston melodic memory test in separating the non-instrumental playing group of Bentley's subjects from the instrument playing group.

3) Fieldhouse's finding that a defective auditory memory was a more important cause of singing out of tune than faulty pitch discrimination. Fry (1948) reported results which tentatively suggested a similar conclusion (see further, p.232 below). But Bentley's "monotones" were significantly below normal in both tonal memory and pitch (Bentley, 1963).

4) The good validity of Drake's memory test and the relatively high validity of Seashore's Tonal Memory test.

The connection between memory and perception must be very close - the more definite and "meaningful" the object perceived, the more likely it is to be remembered, but the better past musical experience has been remembered, the more readily familiar elements of a new pattern of stimuli can be fitted into an existing schema. Speed of musical perception might be a factor of some importance, since McLeish found that speed at the higher level measured by Cattell's timed intelligence test, but not the speed involved in a cancellation test, has an appreciable influence on Seashore's Memory and Pitch tests. Wing's test 2 was deliberately designed to have a speed factor in it. (The 30 items in it take only 3 minutes).

Drake's expression "the auditory nerve" may seem rather an oversimplified description of the complex processes of human memory. It seemed to Hebb (1949) that at least a dual mechanism would be required to account for the instantaneous establishment of some memories and their permanence, i.e. a transient, unstabl reverberatory trace which would carry the memory until a structural growth (requiring an appreciable time) could reinforc it and make it permanent. Accor ing to Cameron (1963, p.337) th belief that memory is a two-stage procedure is now widely held. Drake might well be right that the crucial differences between individuals depend on the relative efficiency of some part of the memory mechanisms. A deficiency (e.g. in the rate of the structural growth required for recall, if Hebb's theory is sound might seriously affect an individual's musical development. As more is learned about the mechanisms of perception and memory in general, more light may be thrown on the relative importance of perception and memory in music.

Franklin considers the strong loadings of the memory tests in factor II and the loadings of the individual TMT test in factors C and G evidence of a connection between TMT and memory. He does not explain why the TMT group test has zero loadings in these two memory factors. Because of the judicious pitch loading of factor II, Franklin concludes that "the connection between TMT and tone memory goes <u>by way of the ear for judicious pitch</u>".

In discussing McLeish's general factor, Franklin's reason for considering that judicious pitch rather than memory is the most important part of such a factor is based on the fact that memory takes only fifth place in the general factor as obtained by Wing (1941) with regard to size of loading. The differences, however, are not large. In any case what might be true of a general factor for the Seashore (w ere the memory test is the most valid subtest) might not necessarily be true for the Wing battery. In Franklin's analyses the factor patterns of the Seashore and Wing memory tests agreed fairly well. Before rotation both had high loadings in the general factors. That he found no evidence of the judicious side of the Wing test, Franklin attributed to the fact that only one of his subjects was able to respond correctly to the most difficult items.

The tentative conclusions which emerge from this brief discussion might be summarised as follows:

Tests which cover a reasonably wide sample of musical talents do yield a general musical factor.

While it may be useful to distinguish between a "sensory" and "judicious" level, such distinctions must not, of course, be sharply defined nor taken to imply e.g. ability to discriminate very small intervalsis opposed to ability to discriminate larger intervals in a musical context. Franklin he may seem to over-emphasise the importance of pitch. (This may be partly because the Wing battery of which he made considerable use is perhaps rather heavily weighted on the pitch side). Admittedly, as he says, "ability in pitch discrimination is a basic precondition of a number of other tests which are not directly intended to measure that ability" (referring to tests of harmony, tone memory and in fact to any test built on melodies). Since music without pitch changes hardly deserves the name of music, if ability to deal with pitch changes is what is meant by judicious pitch it might even be the most important part of a general music factor. But it would seem wiser not to stress too much any one aspect.

Seashore's claim to test "basic" capacities is hardly substantiated, owing to the rather low validity of some of his measures. Tonal memory, which he considered important but not essential, would appear to be a prerequisite to any development on the aural side of music. A "judicious" pitch test like Wing's might be considered "basic" in the sense of being a precondition of success with other tests, and "elementary" in the sense of being "outgrown" by older and more talented children, as is suggested by high, near perfect, scores made by gifted subjects. An even more elementary test was the pitch test used by Bentley (1963) for his pilot investigation (see p. 59 above). 90% of 312 children aged 9 to 11 earned more than half marks.

Creativity and Executive Talent

The distinctions between types of reasoning and the creative imagination of the artist are not so clear as they may appear at first. The new combinations which occur to the composer are psychologically like the trials of a person attempting to solve a difficult mechanical or mathematical problem (Gates, Jersild et al, 1942, p.494). Composing music would appear to involve both a process of technical elaboration and of inspiration. (How much inspiration and how much intellectual working out of ideas differs, of course, with the individual composer). To describe inspiration in terms of the Unconscious, is, as Vernon (1931) remarked, "no more enlightening than calling it 'a gift from God'". Yet it is hard to see how some such term can be avoided; for no amount of conscious effort on the part of a student of composition would enable him to produce worth-while music without "inspiration". This does not mean that the assimilation of the music of other composers is not important. As McGeoch (quoted Hebb, 1949) says of ~~the~~ problem-solving, "Where the subject 'sees into' the fundamental relations of a problem or has insight, transfer seems to be a major contributing condition. It is, likewise, a basic factor in originality, the original and creative person having, among other things, unusual sensitivity to the applicability of the already known to new problem situations". This latter point, the originality of the composer, is one that Revesz (1953) stresses as the "real problem of creative activity". However important recollections and analogies are in the creative process "significant inspirations are independent of already familiar forms to a very great degree" (Revesz, 1953, p.203).

Emotion is commonly thought to play an important part in musical composition. (Artistic creation may possibly be distinguished from scientific insight by the greater amount of emotion it involves). Bahle (1934, cited Wing, 1941a, p.482), for example, gave 30 composers a number of poetic tests, asking each to select one text, to set it to music and then report his introspections. He concluded that the poem must evoke an emotional response which is followed by an attempt to express this in music and that music, therefore, appeared to be an expression of emotion, even under the somewhat artificial conditions of an experiment. It is usual to add that the "emotion must be 'recollected in tranquility' or psychologically 'distanced' or in some way digested or assimilated" (Howes, 1958). Tchaikovsky's "Pathetic" Symphony is sometimes felt to be too 'close' an expression of emotion, i.e. that its emotion is more "emozionalita non elaborata esteticamente" (to use Croce's words). The chanting of children (see Chapter IV) or of savages would seem unsatisfactory aesthetically for a similar reason. In Wagner's words "When a musician feels prompted to sketch the smallest composition, he owes it simply to the stimulus of a feeling that usurps his whole being at the hour of conception". The passionate and lasting emotions which drive the musician to write an Eroica Symphony "may date from outer causes ... but when they force the musician to produce, these greater moods have already turned to music in him" (Wagner, 1841, cited Howes, 1958).

Hebb's hypothesis on emotion might seem to provide a clue to how emotion might possibly function in giving rise to new compositions: "Strong emotional disturbance tends to prevent the repetition of any line of thought that leads up to it" (Hebb, 1949). If some such account of emotion is true, perhaps it might act by clearing the composer's mind of old solutions to musical problems, thus enabling new combinations necessary for original compositions to occur. After the "storm" of the emotion has passed, the ideas may be produced so freely that, as Elgar says, composition seems merely a matter of taking as much of the "music in the air" as the composer requires.

During the actual process of composition, emotion may enter again, now apparently more as a concomitant than as a causative agent, perhaps as a feeling of joy at having found an expression for the previous emotion or in working out or constructing a movement. The composer is often in some kind of state of clairvoyance (Vernon, 1931). What Mozart describes as a "pleasing lively dream" might seem to resemble hypnosis, rather than sleep. According to electro-encephalographic evidence (Grey Walter, 1953) in hypnosis "awareness is not lost, but heightened - restricted, it is true, to specific categories of stimuli, usually the hypnotist's voice" (Beethoven's "inner voice"?). The basic properties of brain function remain undistorted, "so that all the pathways of association and stores of experience are intact". The difficulty of checking such a supposition experimentally would be, of course, finding a composer whose inspiration did not desert him in laboratory conditions.

Creative ability is very hard to test, even by individual methods (Wing, 1948). Vater (1934) and Vidor (1931) gave their subjects a tapped time pattern on which to build a tune. Such tunes could be sorted out, Wing suggests, into typical shapes, on similar lines to the drawings of a man at various ages. In the case of children with marked creative ability, Revesz's approach of attempting to study their spontaneous compositions from the point of view of originality and development of individual style might be more promising.

The composer certainly requires a high degree of musical ability and at least some knowledge of the technicalities of any instrument for which he writes. In fact, many composers have shown, as did, for example, Chopin and Liszt, considerable talent as instrumentalists. How far this is a matter of two distinct abilities being combined in one individual or of one ability being shown in more than one direction is difficult to judge. Revesz believed that creative talent and interpretative talent were distinct and, rightly, points out that virtuoso performers rarely produce original compositions of much worth. This might be largely due to the demands made on their time and energy by the exacting nature of their profession. Personality factors may also partly determine whether an individual turns to performance or composition, (Wing, (1941a) believes composers tend to be introverts and performers, extroverts). Vidor (1931) found for the thirty-five children of varied ages she tested very little evidence of distinctive creative and perceptual abilities, but none of her subjects evidently had an unusually high creative talent.

It might seem likely that creative talent would be relatively closely connected with the interpretative side of performance, if not with the technical side. Like the composer, the interpretative artist seems to draw upon "subconscious" sources for the solution of his problems. Thus Bruno Walter (1961) refers to the "psychological phenomenon that must be familiar to every gifted re-creative musician. Whenever I had been in doubt for some time about the right speed for a musical phrase or episode, it happened that I was suddenly faced with a decision coming, as it were, from a deep region of my mind; as in a moment of revelation the right speed had dawned on me, giving me a feeling of complete certainty".

Tests of aptitude for the executive side of performance have received much less attention than those for the aural side (Jacobs, 1960). Seashore (1919) did include tests of strength of grip, precision of movement, timed action etc., among those he thought necessary for a complete talent chart of the prospective music student. But like his measures of sensory capacities they were probably on too elementary a level to be useful. Whittington (1957) found only very low correlation between musical age (as measured by the Wing tests) and manual dexterity tests. There appears to be a need for tests of manual dexterity at a higher level, which would be valid for instrumental performance; for Cleak (1958) mentions many cases of pupils whose attempts to learn an instrument ended in failure because of difficulties on the technical side, though they had a good ear for music. Wing (1948) was probably exactly right to call the aural ability required for his test a prerequisite, but no guarantee, of performing ability. In any case, as will be suggested in Chapters IV and V below, the auditory and kinaesthetic sides of musical ability appear to be intimately connected from a very early age.

"Musicality" (Aesthetic Appreciation of Music)

"Musicality, primarily, denotes the ability to enjoy music aesthetically" (Revesz, 1953). In his view, musicality is to be distinguished from a) creative or interpretative talent, b) aural abilities (such as capacity to discriminate rhythmical and tonal relationships) and c) affective response to music, or love of, or interest in, music.

While recognising that there are various degress of musicality from the very pronouncedly musical downwards, Revesz states that "to be considered musical a person must possess several" of these characteristics:

Ability to contemplate a piece of music as a work of art, to assimilate it and to co-ordinate what he has heard, following the parts without separating them from the whole; to be sensitive to the artistic quality of composition and performance; to understand the structure of the work; to follow, even to anticipate, the composer's intentions; and to become so absorbed in the emotions expressed that he feels as if he were creating it.

For Hevner and Mueller, too, the aesthetic response to music is highly attentional, with every detail being followed and "making the experiencing of it a forceful and vivid awareness" (Hevner, 1937). It involves a keen perception of the music's qualities, of rhythm, harmony, melody or all these elements combined, without which its beauties may be completely lost. The affective accompaniment gives the response importance and significance. The feeling reaction is not so intense that it completely absorbs the listener's attention, but may be sustained over a long period. According to Hevner and Mueller, it is the background of widespread and unlocalised bodily sensations, especially from the involuntary muscles and viscera which give the experience affective and emotional qualities.

Vernon (1931) emphasises that there is "no one standard experience which can be called the aesthetic, but that it is a synthesis of all the various tendencies, different for every individual. It should include as many diverse elements as possible and it is the presence of overmuch attention to any one aspect (be it intellectual, emotional, gregarious, or anything else) to the detriment of the whole that really constitutes the non-aesthetic factor in musical appreciation". In the highest moments "which occur but seldom" the various elements"integrate into a total cognitive affective experience" Support for this view was shown by the rankings for aesthetic appeal of items played at two experimental concerts. These did not run parallel either with the marks for intellectual interest, nor with those for emotion, but were rather closely parallel to the sum of both.

Though Revesz distinguishes between musicality and musical ability, the appreciation of form would seem to imply ability to recognise a theme when transposed or rhythmically or melodically changed (i.e. the ability tested by Drake's Memory test). Sensitivity to the finer points of style would seem to require the sort of ability tested by the Oregon or by Wing's last four tests. The last tend to be distinguished from the aural acuity tests of Wing's battery in only a relatively minor factor (see above). Doubtlessly, musical ability correlates positively with the higher levels of aesthetic experience, bath as to quality and frequency. However, it would seem wrong to deny the genuineness of aesthetic experience of persons with only a modest amount of musical ability. Grillparzer's character of the violinist in Der Arme Spielmann who delighted in sustaining a single note, then alternating it with the fourth, the fifth and the third above (Bruno Walter, 1961) was certainly as highly attentive, as keenly perceptive and as emotionally responsive to this very simple musical activity as a trained musician to a Bach fugue. A high degree of musical ability is no guarantee of a high degree of aesthetic appreciation on any particular occasion. Aesthetic appreciation has something of the elusive quality of the composer's "inspiration". A concert-goer cannot say "When I hear Beethoven's Missa Solemnis performed to-night I will have a profound aesthetic experience" any more than a composer can say "I will have an inspiration for a new symphony after breakfast to-morrow morning".

Insofar as the listener may enter into the music so completely that he feels he is creating it, it might seem that the creativity of the composer differs in degree rather than in kind from that of the "musical" listener. At least some of the distinction between musicality and creative or interpretative talent might appear due to lack of opportunity to learn to compose. There is certainly an enormous difference in opportunity for the child to learn to express himself in music as opposed to words. The musical equivalent of routine oral class composition in English was apparently so exceptional in musical education that it provided material for a series of journal articles (Doig, 1941-2). However, in spite of all the attention given to composition in the vernacular, the number of persons becoming great writers or poets remains small. The great variety of literary productions might fit into a continuum from the lowest to highest, with, as Burt (1943) suggests, a few individuals at the top showing really outstanding achievement. The comparativ lack of opportunity to compose music may result in fewer compositions of lesser merit being produced, rather than affecting the higher levels of creative achievement. (This assumes that "genius will out" or outstanding talent will tend to find opportunities for expression even in an unfavourable environment).

CHAPTER III

THE RELATIONSHIP BETWEEN MUSICAL ABILITY AND OTHER ABILITIES

The relationship between musical and other abilities has some relevance to the present investigation, for reasons such as:

a) it might be true, as Mursell and Glenn (1931) supposed, that it is a high level of all-round ability rather than a specialised talent for music that is inherited from the parents, this high all-round ability becoming canalised in music by environmental influences;

b) how far a child's musical ability can be influenced by the environment might depend on his general ability level as well as on his musical ability;

c) how far any general factor from music tests is due to general ability and how far due to special musical factors or some common factor such as attention, may also become clearer.

Musical ability and General Intelligence

The results obtained by various investigators from comparing intelligence tests scores with scores on musical ability tests are shown on the following table. In nearly every case the results are expressed as coefficients of correlation.

Most of the correlations are positive but low. Both Wing and Kwalwasser refer to .30 as being the approximate correlation to be expected from normal subjects. Wing

Table IV. Correlations between Intelligence Tests and Musical Ability Tests

Investigator	Subjects	Intelligence Test	SEASHORE MEASURES					
			Pitch	Intensity	Time	Consonance	Tonal memory	Rhythm
Weaver(1924)	94 College students	Army Alpha	.35	.24	.12	.06	.26	-
Fracker & Howard(1928)	230 College Students	Otis and Army Alpha	.32	.01	.13	.09	.10	.12
Highsmith (1929)	59 female music school students	Terman Group & Thurstone Psych. Exam.	.58	.35	.39	-.14	.30	-
Salisbury & Smith(1929)	131 training college students	Thorndike Exam for High School Grads.	.31	.15	.30	.00	.24	.02
	144 training college students	" " "	.39	-	.49	.38	.33	.24
Farnsworth (1931)	150 University students	Thorndike Intelligence Exam.	.14	.11	.10	-.38	.11	.17
Drake(1940)	163 boys age = 13	Army Beta type	.12	.14	.08	.03	.07	.05
Franklin (1956)	79 training college students	Anderberg a.	.13				.00	
	157 training college students	Thurstone Mira b.	.15				.14	
Hollingsworth (1926)	49 children with IQs above 135		Median P.R. 46.7	50.0	58.0		52.3	

Investigator	Subjects	Intelligence Test	Pitch	Intensity	Time	Consonance	Tonal memory	Rhythm
			SEASHORE MEASURES contd.					
Manor(1950)	4th grade children	California Elementary	.21				.27	.11
				KWALWASSER-DYKEMA TESTS Full Battery				
Newkirk* (1934)	1000	Otis		.34				
Robertson* (1941)	over 5000 children aged 8 to 20	Otis and Kuhlmann-Anderson		.33				
Lambert* (1941)	1,024 children age = 11	Kuhlmann-Anderson		.33				
Lehman(1950)	450 musicians & college students	Otis		.18				
Chase*(1931)	82 feeble-minded children (IQ range 45-77)	Not stated		Average P.R. = 35.0 (tests 1-8)				
Drake(1940)	as above			.06 (melodic taste) .13 (tonal movement)				
						KWALWASSER MUSIC TEST Full Battery		
Radley* (1952)	550 children	New California (shortened)				.51		

*cited by Kwalwasser 1955.

Investigator	Subjects	Intelligence Test	KWALWASSER MUSIC TEST contd. Full Battery		
Bentley, R. (1955)	a. 87 instrument playing music students	California Test of Mental Maturity	.34		
	b. 95 non-instrument playing music students	" " "	.46		
			LOWERY TESTS		
			Tonal memory	Cadence	Phrase
Lowery(1929)	Group of school girls aged 12 - 14	Tomlinson West Riding set y	.44	.44	.00
Drake(1940)	as above			.06	
			MAINWARING TESTS		
			Pitch	Rhythm	Recall
Mainwaring (1931)	83 Elementary school children	N I I P Group	.53	.46	.04
	34 grammar school boys	Spearman's Measures	.39	.32	-
			DRAKE TESTS		
			Memory		Rhythm
Drake	230 College students	Otis Advanced	.28		
Drake	163 Music students (aged 7 - 16)	Army β type	.27		

Investigator	Subjects	Intelligence Test	DRAKE TESTS contd. Memory	Rhythm
Drake (1957)	20 High School children	Cattell Culture Free	.05	.10
Drake	61 Psych. students	Otis Advanced		.00
Drake	130 students	A.C.E. College		-.03
Drake	130 students	Cattell Culture Free		.05
Karlin(1941)	120 students	Cattell Scale III	.06	

			OREGON MUSIC DISCRIMINATION TEST
Hevner(1931)	74 College students	Minnesota College ability test	-.15 (2 version form)
	74 " "	" " "	-.17 (4 version form)

Investigator	Subjects	Intelligence Test	Full battery	Chords	Pitch	WING TESTS of MUSICAL INTEL. Memory	Rhythm	Harmony	Intensity	Phrasing
Wing(1948)	23 girls	Simplex Junior	.30							
	42 boys	Burt's Reasoning	.32							
	24 adults	Terman & Merrill	.40							
	24 adults	Cattell IIIa	.34							
	454 college students	Group 33	.20							

Investigator				WING TESTS contd. Full battery	Chords	Pitch	Memory	Rhythm	Harmony	Intensity	Phrasing
Edmunds(1960)	Sec.Mod.school-children:										
	60 A & D stream	Cornwell	Tests 1 to 3	.28	-.07	.33	.39				
	58 F stream & E.S.N.	Cornwell		.39	-.02	.36	.47				
Coulthard (1952)	32 grammar school boys	(IQ=126)		.04							
Shuter(see Chp. XII)	200 Royal Marine School of Music boys	Admiralty Abstraction				.180(Tests 1-3)				.154(Tests 4-7)	
Whittington (1957)	24 musical adolescents	Raven's Matrices			.36	.18	.42	.40	.47	.52	.20
	24 unmusical adolescents	Raven's Matrices			.21	.63	.32	.20	.17	.00	.40
Bentley, R	as above		a)	.39	.21	.39	.37	.22	.18	.01	.02
			b)	.39	.22	.39	.26	.03	.25	.17	.11
Franklin	as above		a)		.09	-.10	-.02	.00	-.19	.20	.04
			b)		.09	.12	.20	.23	.21	-.03	.08
Holmstrom (Wing 1957)	900 children 8 years old			.37(modified form of tests 1-3)							

Investigator	Subjects	Intelligence Test				LUNDIN TESTS		
Lundin(1949)	113 Music students	California Maturity	Total			.15		
"	" "	" "	Language			.13		
"	" "	" "	Non-language			.25		
	155 Unselected music students	" "	Total			.24		
	" "	" "	Language			.19		
	" "	" "	Non-language			.22		
				WHISTLER-THORPE TESTS				
				Rhythm	Pitch Recog.	Melody	Pitch discr.	Rhythm
Bentley	as above		a)	.25	.22	.32	.35	.26
			b)	.00	.24	.22	.32	.01
						GASTON TEST		
					Tests 19-23	Tests 24-28	Tests 29-33	Tests 34-40
Bentley	as above		a)		.15	.32	.29	.29
			b)		.11	.18	.16	.25

Investigator	Subjects	Intelligence Test	FRANKLIN TMT TESTS	
			Group	Individual
Franklin	as above		a) - b) .18	-.11 .18

Investigator	Subjects	Intelligence Test	BENTLEY MEASURES OF MUSICAL ABILITY				
			Full battery	Pitch	Memory	Chords	Rhythm
Bentley, A. (1963)	166 children aged 10 to 12	Moray House Verbal Reasoning	.385	.30	.25	.25	.35
	149 children with IQs of 100 or above; age = 11:1	" " "		assoc. signif. at 1% level	no significant association		

further states that in calculating his coefficients agreement was noticeable between a very low IQ and a low MQ and disagreement was found where a high IQ was present with a low MQ (Wing 1941a, p.320). Burt, in his use of the Seashore tests, suspected that intelligence was a help for younger children but that this tendency was apt to disappear later. Both the results of Edmunds and of Coulthard confirm this tendency. Edmunds comments that low intelligence and low musical ability appear to be closely related, but when a certain level of general ability is reached, approximately IQ 90, intelligence no longer plays a significant part, i.e. children may have either a high or low MQ.

The average correlation for the Wing tests with Raven's matrices was .36 for Whittington's musical group and .28 for the unmusical group. There was no significant difference at the .01 level between the means of the Raven scores of the two groups. The Raven test had a somewhat higher ranking, i.e. third place in the first factor solution of his factor analysis for the unmusical group than for the musical group (seventh place). This lead Whittington to suggest that his unmusical subjects possibly utilized "intelligence in a finer form to appreciate a 'gestalt' quality in the tests". This form of intelligence was not to be identified with Spearman's 'g'. It certainly seems likely that an unmusical child who has to attempt music tests would try to make up for his lack of musical ability by "intelligent" guessing. If, for example, Wing test 1, item 1, sounded like two notes, item 2 might sound like "less than 2, therefore 1", while he might deduce that as item 4 appeared to have more notes than either 1 or 2, it might have 3 notes. As mentioned in Chapter II above, Burroughs and Morris (1962) found that intelligence appeared to be of some help in the early stages of learning a musical task, though their results do not show if this is particularly true for the less musical. While successful guessing may bear some relationship to intelligence, how far it can be distinguished from Spearman's 'g' is a different matter.

The highest correlations on the above table occur in the case of the less fully standardised or less reliable tests such as Lowery's tone memory and cadence tests and Kwalwasser's Music test (Cf. Chapter I). In the case of the Mainwaring tests the group giving the higher correlations consisted of children subnormal in intelligence. With a more normal group the coefficients fell to the 30s.

Bentley, R (1955) expressed concern that his correlations were higher than those reported by Wing, but there appears little ground for thinking that the better standardised tests are unduly affected by intelligence, though no doubt, as Wing (1962) agreed, further research is needed. As intelligence is a help in using musical aptitude, it probably does not matter greatly, for practical purposes of predicting future musical achievement, if to a limited extent the tests also measure general intelligence.

The coefficients in the above table are to some extent doubtless a function of the particular intelligence test used. As might be expected by the abstract nature of music, non-verbal tests appear to yield somewhat higher correlations. This is, for example, shown in Lundin's results. However, the relationship between the language and non-language parts of the intelligence test seemed to differ from music sub-test to sub-test and from group to group. Lundin, therefore, considered it unwise to draw any conclusion.

Wing's view of the matter is that "musical intuition" (i.e. the rapid mental understanding of the music or musical tasks) may be regarded as a form of intelligence, "although it might not be adequately measured in the normal intelligence test which deals with logical reasoning" (Wing 1941a, p.428). There may be much truth in this view, but since most intelligence tests do very largely involve reasoning, verbal or number factors, one might wonder what form this other type of general ability could take. Perhaps it might involve what Hearnshaw called "temporal integration" (Hearnshaw 1951). Again, "rapid mental understanding" suggests that one of McLeish's conclusions from his factor analysis (see Chapter II above) might be worth further research. McLeish (1950) found that "speed at the higher levels measured by Cattell's timed intelligence test has an appreciable influence on the Seashore Memory and Pitch tests". Speed may be even more important to music, than for example, to mental arithmetic; for while many other tasks can be practised at the learner's own speed or with erratic variations, too slow or erratic a tempo quickly destroys the character of the music.

There appear to be few consistent tendencies in the correlations between the sub-tests of the music batteries and the intelligence tests. This may be partly because many of the sub-tests are not so reliable when taken separately. Memory tests usually give, as might be expected, moderately high correlations, but pitch tests are often slightly higher still. Burt in an early research (1909) found sizeable correlations between intelligence and pitch discrimination. He thought a possible explanation might be the dependence of the development of intelligence in man upon the power of speech and of this in turn upon auditory acuity. But, while Franklin found the Seashore pitch test had a loading of .42 in Factor III, a factor closely associated with intelligence, the Wing pitch test had a zero loading (see also p. 80 above). In a second and larger factor analysis, both pitch tests showed zero loadings in the factor most saturated with intelligence. High loadings for the rhythm tests appeared in the first analysis, but were not confirmed by the second. A possible interpretation of Factor III as an attention factor is discussed by Franklin: "One need not be particularly bold to claim that Factor III places the tests in approximate rank order with regard to the degree of attention needed to reach a good test result". Such an interpretation was not, however, wholly acceptable because of the difficulty of finding an attention factor in the larger study, where the "intelligence loadings have been split up partly into a pure intelligence factor (D), and partly into a factor (J) where the main emphasis is on the TMT group test". The TMT group test requires "an evaluating judgment with regard to a synthesized collection of sensory impressions of different kinds". Franklin believes that he has here found "an indication that the higher the nature of the musical functions the further we pass away from the sensory level, and the more we approach a level where general intelligence and special intelligence join forces, mutually supporting each other. In the case of the great creative artists, the great composers, conductors, music theoreticians, and writers on music, this must undoubtedly be the case". (Franklin 1956, pp.158,159, 164-168).

This is certainly a very interesting point of view which future research may verify. But, Franklin continued, "investigations concerning the connection between musical and general intelligence must be made at the same level" and not, for example, by comparing exclusively sensory tests with intelligence tests. Verbal talent, he suggests, should be correlated with phrasing ability, or something similar to it. That the musically great men of history possessed far better than average intelligence is well established (Farnsworth 1958, p.183). Cox (1926) estimated Bach's IQ to lie between 125 and 140, Beethoven's between 135 and 140 and Mozart's between

150 and 155. Taken as a group, however, the 11 musicians had the lowest IQ of all the eminent men whose biographies she studied; they were also the least versatile (White 1931).

Musical Ability and Educational Achievement

Mursell (1937) concluded from the data then available that when functional criteria of musicality are employed such as teachers' estimates, musical ability may show a quite close of association with educational attainments. Examples of the results he had in mind are: Miller (1925) concluded from a study of the school records of 826 men students at a teachers training college that all-round talent usually includes musical talent, and those who are good musicians usually possess good general ability, while those who show poor general talent are rarely good musicians, and then not "constructive", but densory or perceptual in their musical reactions. Schüssler (1916) compared 200 musical and 200 unmusical pupils of elementary and intermediate schools and found that the school achievement of the musical was 15% better than that of the unmusical. The Pannenborgs (1915) made an elaborate investigation of 423 musical adults, of whom 52 were outstandingly talented, and of 3,860 school children, of whom 404 were considered highly musical. The highly musical were found to be distinctly superior in general cultural achievement.

It is difficult to assess how far personality factors, such as willingness to work hard, are influencing these results, Moreover, as Drake (1940) pointed out, teachers' estimates are liable to be highly saturated with the "halo effect" of the pupil's other school work. Even when this type of criteria is employed, the results are not always consistentl in favour of any definite association between musical-scholasti achievement. Thus, Bartsch could find no clear-cut relationship between musical aptitude and ~~the~~ general intellectual ability as testified by the term reports of 200 moderately musical pupils at a teachers seminary (Revesz 1953, p.161.)

Terman (1947) emphasised the versatility and many-sided interests of gifted individuals. However, his sample of gifted children particularly excelled in those subjects which required abstract thought and were only slightly better than average at instrumental music and singing. The mean ratings by their teachers on a 7 point scale (1 = highest rating) were 2.89 for instrumental music and 3.24 for singing compared with the control group's 3.38 and 3.89 (Terman et al 1925).

Drake (1940) studied the relationship between the scores on his Memory test and the College grades of women students. The correlations ranged from -.13 for Social Science to .24 for Chemistry. The correlation between musical memory and a score representing the total quality credits earned by each student (n = 230) was .16. In a study of 180 Psychology class students a correlation of .08 was found between the Drake rhythm test and cumulative grade-points (Drake 1957).

Wing (1954, p.167) too reported low correlations (of a similar order to those with intelligence tests) between scores on his tests and school certificate marks in a number of subjects.

It seems reasonable to conclude that music is aided by all-round mental efficiency (Wing 1948, p.65) and by such factors as willingness to work hard, but that general educational achievement is by no means always accompanied by success with music or vice versa.

Table V. Correlations between te ts of Musical and other Abilities

(In no case has general intelligence been partialled out)

INVESTIGATOR	SUBJECTS	MUSIC TEST(S)	Foreign language	Native language ; Vocabulary	Spell
Franklin (1956)	157 Training College Students	Seashore Pitch		.26	
		" Memory		.17	
		Wing 1 Chords		.13	
		2 Pitch		.18	
		3 Memory		.28	
		4 Rhythm		-.01	
		5 Harmony		.27	
		6 Intensity		.00	
		7 Phrasing		.13	
		Franklin TMT Individual		.23	
		" Melodic Rhythm		.19	
Edmunds (1960)	60 Sec.Modern A & D stream	Wing 1-3		.33)Burt's Re	
	58 " " F stream & ESN	" 1-3		.24) test	
Coulthard (1952)	32 Grammar School boys	Wing 1-7	.53		
		" 1-3	.42		
Shuter (see Chap. XII)	200 Royal Marine School of Music boys	Wing 1-3			.1
		" 4-7			.1
Drake (1957)	19 Music Students	Drake Rhythm			
	166 Belgian Schoolboys	" "			
Karlin (1941)	120 C llege Students	Drake Memory		.14	
Carroll (1932)	133 College students	Hevner Appreciation			
Williams, Winter & Woods (1938)	Over 200 children aged 11-17, male	Appreciation			
Morrow (1938)	112 male Psychology students	Kwalwasser-Dykema (tonal Memory, tonal Movement, Time and Rhythm D scrimination, Melodic Ta te)			

Musical ability and other abilities

Table V shows correlation coefficients obtained from comparisons of tests of musical ability with tests of various other abilities:

In only one case is the correlation above .50; that of oral French. Though Coulthard tested only a relatively small population, his test of oral French was quite an extensive one, including sub-tests of Pronunciation, Accent, Intonation, Phrasing and Fluency and lasting 160 minutes. This result confirms the popular view that musical children have an advantage when it comes to learning a foreign language.

The correlations between the measures of musical ability and English suggest that both might be influenced by a common factor of general ability.

In his larger factor analysis Franklin found that a factor which had strong loadings in the tests of visual form perception also had small, hardly significant loadings in the two tests on melodic Rhythm (Wing's and Franklin's own). Franklin suggests as Rhythm is very "important for musical form these small loadings might indicate something in common for the perception of visual and musical form. Thurstone, for example in his factorial study of perception, mentions that the factor 'facility in perceptual closure' might transcend the different modalities". (Franklin, 1956, p.159).

Two important areas with possible particular connection with musical ability are ability in the other arts and mathematical/scientific abilities. These are discussed separately below.

Musical ability and ability in the other arts

One of the conclusions which Feis (1910) drew from his data on the genealogy of great musicians is that their parents have often been distinguished in other arts or literature. This suggested to Mursell and Glenn (1931) that distinctive musical ability is a manifestation of a general high level of all-round ability, and particularly of a high level of artistic and literary ability.

The actual correlations of test results are, however, not very high. When general intelligence had been partialled out, the literary tests of Williams, Winter and Wood showed a barely significant correlation (.16) with a test of musical appreciation. The investigators claimed that "this largely confirms Burt's inference from his earlier test results that 'in criticism, if not in creation, in the vast majority of persons, if not in the specialist, and in the young if not in the old, aesthetic appreciation is dependent upon a group factor common to all the various media, as well as upon general intelligence and special capacities peculiar to the different forms'". As in the case of Carroll's results, their test of literary appreciation correlated rather higher with an artistic judgment test than either did with music.

The above two investigations had the merit of comparing appreciation tests in the various media. Morrow, however, attempted to correlate the Kwalwasser-Dykema tests, which are largely discrimination tests and none too valid (see Chapter I), with the Meier-Seashore Art Judgment tests and the Stenquist Picture (Group) Test No. II and Lewerenze Tests in the Fundamental Abilities of Visual Art. Many of the inter-correlations proved to be lower between the sub-tests of the batteries than between the different abilities. Morrow reached the conclusion that there was a closer relationship between artistic and mechanical abilities than between either and musical ability.

In his analysis of possible components of creative abilities in the arts, Guilford (1957) points out that there is a precedent among the memory factors for a distinction between visual and auditory functions. That auditory memory appears to be separate from visual memory suggests to Guilford that similar distinctions may be found between the abilities to produce and to express ideas in the graphic arts and the parallel abilities in music. Though he considers these may be distinct, they may not be necessarily independent or uncorrelated. In fact, he suspects that there _is_ something in common among the parallel factors in the different arts (apart from the co-incidence of some individuals having talents for more than one). He proposes, however, first to measure the factors for the different media separately, then to investigate any intercorrelations.

It has seemed to psychologists such as Torrance (1960) that there is an important group of children who do well in 'creative' tests, but less well in intelligence tests, and whose ideas tend to 'diverge' from those of their class-mates and teachers. (Those who make high scores in intelligence tests tend to conform rather more easily with the ideas of others). In such a broad classification it is possible that a high proportion of artists of all kinds would find themselves in the 'divergent', 'creative' group. But, the evidence so far available would seem to suggest that the musicians in particular would be divided from their fellow artists by a rather highly specialized ability. Any correlation might arise from personality, rather than cognitive, factors. While it may be true, as Bühler (1935) appears to think, that young children will take up any art that happens to be readily available in the environment as a means of expressing themselves, there is little evidence that individuals would be equally good at any art.

Musical ability and mathematical/scientific abilities

In the words of Frank Howes (1958) "the analogy between mathematics and music has been recognized from antiquity, and though all attempts to press the analogy, or even to define it, soon break down, it is still recognized by musicians and mathematicians and the rest of us who are neither ... as a way of thinking in relationships, abstractions - there is an obvious similarity...". Thinking-cum-feeling in formal patterns of mensurable units and relations, he goes on to say, appears to be a good description of a sonata movement as of mathematicizing.

One difficulty which arises in trying to investigate the connection between the two abilities by testing is due to the very different treatment mathematics receives as a school subject. Considerable attention is given to arithmetic and other branches of mathematics and its utilitarian value as an examination subject is apparent. Music, except for the very talented, may seem to have much less importance, except as a hobby. For the very talented music requires a considerable amount of time - no doubt often at the expense of other studies. Even if they had much aptitude for mathematics, many musicians may have had little time or opportunity to develop it. Revesz (1953) found only 9% of professional musicians had mathematical talent or interest in mathematics. Some of the apparent lack of aptitude may have been due to lack of opportunity, or even to the attitude of being "above" practical, everyday affairs affected or genuinely felt by some musicians*, and the lack of interest due to mathematics not entering very largely into the popular hobbies. One wonders what percentage of the population of comparable socio-economic status to the musicians <u>would</u> express an interest in mathematics.

The results of correlating music and mathematics tests certainly do not reveal any close connection. Wing (1954, p.167

*Beethoven is reported to have been "unable" to master the multiplication tables.

correlated performance on his tests with School Certificate results and came to the conclusion there appeared to be little relationship that could not be attributed to another common factor e.g. memory, attention or general ability. Of all the correlations between the Wing tests and the Admiralty entrance tests calculated by the writer (see p. 376), those for the mathematical tests were the lowest. Success in the latter could however, have been at least partly due to good teaching. Though such tests do, of course, measure number ability, computational efficiency is not always synonymous with a true understanding of number (Williams, 1958). College grades in Chemistry and Mathematics showed higher correlations with Drake's Memory test (.24 and .22 respectively) than did any other of 16 subjects, but the coefficients were not significant (Drake, 1940; see also p.123 above).

In order to find out if mathematicians were more musically gifted than exponents of other professions, Revesz (1946, 1953) sent a detailed questionnaire to 528 Dutch mathematicians, physicists, physicians and writers. Among the questions on playing, singing, composing and concert-going, there were only six concerned with aural ability and two of these were on absolute pitch. It is not clear how much weight Revesz gave these in axsessing his results, which are shown in the table below:

	n.	Musical	Unmusical
Mathematicians	135	56%	44%
Physicists	172	67%	33%
Physicians	165	59%	41%
Writers	110	71%	29%

Revesz's results cannot be considered entirely conclusive; it is questionable how far trying to assess musical ability by questionnaire is a valid procedure. The writers might have been inclined to answer less objectively than the scientists, though they might be expected to be sensitive to sound. While the mathematicians no doubt all possessed a high degree of mathematical talent, the same is likely to be true of most of the physicists and some of the physicians.

Haecker and Ziehen (1922 cited Revesz 1953) found what appears to be a negative relationship between mathematical and musical ability; out of 72 completely unmusical males, 13% had mathematical aptitude; out of 227 musical males, only 2% showed mathematical ability. Pannenborg (1915 cited Revesz 1953) also found only a small difference in favour of the musical. Of 52 subjects with pronounced musical talent, 15.4% showed mathematical aptitude, while in the case of 371 averagely musical persons, the percentage was 12.3. On the other hand, Platt (1942) found music students rated 4.61 points higher (C.R. = 3.8) than non-music students on mathematics test scores.

Vernon quotes the following evidence of a positive relationship between music and mathematics: "Of the 200 odd members of the Oxford University Music Club and Union during the year 1927-8, at least 60% were scientists (including mathematicians and medical students), while in the University as a whole the proportion was scarcely 15%" (Vernon 1931, p.117). Membership of the Music Club was presumed, reasonably enough, to be indicative of ability to appreciate good music.

At first sight this might appear to mean no more than that scientists feel the need for a spare-time interest among the fine arts. Music might then be chosen merely because it offered the most contrast to their normal occupation. However, there might in fact be some real correlation of abilities to deal with abstract configurations which are involved in both mathematics and music. This might be particularly true of individuals highly integrated intellectually. A senior University might be expected to attract scientists of higher intellectual calibre and of more highly cultured backgrounds than a technical college. It would be interesting to know if technologists of lesser institutes also show a marked tendency to choose music as a spare-time pursuit.

Conclusions

The evidence so far available suggests that musical ability is largely specific. There is a fairly well established connection between general intelligence and musical ability in the case of younger and less intelligent children. It seems reasonable to interpret such a correlation in terms of some common ability, such as powers of attending, concentrating or following instructions. For the more intelligent the musical ability of the child depends more on the special musical factors than it does on his intelligence. Positive correlations are nearly always found between measures of musical ability and other cognitive aptitudes. However, except in the case of an oral test of French, the coefficients are low. Further research is needed before any connection with aesthetic ability in the other arts or with mathematical/scientific ability could be accepted as established.

CHAPTER IV

THE DEVELOPMENT OF MUSICAL ABILITY

The aim of this chapter is to examine briefly the observations reported on the growth of musical perceptions and responses of very young children to try to discern how environmental factors may interact with the congenital at this early stage of life.

Though few in number, the available reports refer to a variety of environments and to children apparently different in capacities.

Wing's account (1941a, p.366) of the musical development of his two daughters up to the ages of 4 and of 2 is probably the most detailed and accurate. As "the opinions formed from an intensive study of these two children were checked by as much evidence as could be collected concerning other very young children", Wing considered that "it may be reasonably assumed that the process of development is likely to follow along similar lines for different individuals". Since both parents were musicians, the Wing children grew up in an exceptionally rich musical background. The elder daughter appears to have been especially talented. The difference between the two sisters at such an early age in a similar environment may be considered evidence of the importance of hereditary factors in musical capacity. It is interesting to note that the difference has been verified in their careers in life. The elder has become a graduate teacher of music while the younger, though a fairly competent cellist, studied medicine. In his remarks on musical education, Wing had in mind the resources of the ordinary home and school (i.e. withou the special equipmentavailable at the Pillsbury Foundation Schools described below). Though he stresses the importance of children enjoying music, he advocates a more positive programme of guidance and of orientation towards the diatonic music of the West than was the policy at Pillsbury.

Among the general accounts of the first years of life which include mention of auditory and musical responses are the writings of Preyer (1892) and of Shinn (1907). Even if the interpretations offered by these writers need modification in the light of subsequent research, their observations seem to have been carefully carried out and still have value. Preyer kept a complete diary of observations, made at least three times a day, of his own son from birth till the end of the third year. Shinn's data were based on close observation of her own niece, supplemented by material, mostly also biographical, from other sources. These children grew up before the days of radio and gramophone, but at least in the case of Shinn's niece and Preyer's son, in reasonably musical homes. Neither child seemed to show any marked talent in responding to its relatives efforts to elicit musical responses. Shinn (p.188) reported that in later childhood her niece "developed a fair average musical taste, and correct perception of time and pitch". Unfortunately this is the only child mentioned by Shinn for whom there is any evidence as to its later development and achievements.

Shirley (1933) was able to include some data on music in "The First Two Years" based on material from daily record sheets kept by the mothers and from frequent home visits to some 20 babies.

The disadvantage of biographical material are that the observer (however objective he tries to be), especially if he is also the parent, may tend to overestimate the child's abilities, or to interpret the behaviour in the light of his own adult preconceptions. 85% of biographical studies examined by M.C. Jones (1925) reported development more rapid than the norms established for large representative groups of infants. If inheritance is at all a factor, this may be largely due to the children being in fact superior; for parents interested and intelligent enough to keep and publish records would tend to have superior ability. In the case of music, at least one parent must have a sufficiently keen ear to be able to identify the child's responses in notation, apart from singing or playing to the child. Such parents are also likely to provide a musically stimulating environment. But, as Allport (1937, p.125) remarked, "even with these limitations the intensive study of the single child has its advantages over the present more popular method of an impersona observation of masses of children". One such advantage is that the child is observed in its normal home environment.

On the other hand, summaries of typical forms of behaviour at various ages form useful supplements to the biographical material. The cultural and creative activities listed at 5 ages between 18 months and 4 years by Gesell and Ilg (1943) include music.

An important source of data on the musical behaviour of young children is to be found in the reports of Moorhead and her associates at the Pillsbury Foundation School, California. This school was set up to study "the music of young children, to discover their natural forms of musical expression and to determine means of developing their musical capacities, particularly in the field of spontaneous creation". Most of the children, whose ages ranged from 1½ to 8½ years, remained in the school for one or two years. Between 20 and 27 were on the register at any one time. The school was equipped with instruments chosen for simplicity, variety, intrinsic worth and adaptability to the purposes of the children (Moorhead & Pond, 1942). These included a number of oriental instruments. In this carefully designed environment the children were left free to sing and to play as they pleased with a minimum of guidance. As far as possible all the music produced by the children was noted, or recorded mechanically, and all activities which seemed to be musical were described. A very broad definition of music was adopted. The uses of the voice in speech were considered to be very similar to its use in song. All sounds produced by striking on hollow blocks or on the floor were considered sufficiently similar to the rhythmic patterns produced on percussion instruments to be counted as embryonically of musical value. The published reports do not state how the pupils were selected. Such a school would be likely to appeal to parents who were musical, or at least interested in music, themselves. Three children whose individual progress is described in detail (Moorhead et al, 1951) are stated to have come from good homes where they had the opportunity to hear good music, but none lived in an environment where music was a central interest. If these homes were typical, the children were likely to be rather above average in musical ability. (To some extent musical ability tends to be positively associated with cultural background - see p.277 below). It is not usually made clear in the published reports at what ages the various activities occur in the children. No doubt the younger and less musical pupils learned a great deal from their more talented playmates.

Earliest Responses to Music and Sounds

The development of musical perception may be considered (Vernon, 1934) a process whereby the indefinite listening of the new-born child becomes the definite listening of the musical adult, which in the case of the trained musician approximates to ordinary perception of speech. Gardner Murphy (quoted by Taylor and Paperte, 1958) describes three stages in the general development of perception: 1. the highly diffuse perception of unresolved blurs of melting patterns in a practically homogenous field, 2. the field resolved into unrelated but differentiated areas, 3. harmonious integration. The early stage of diffusion precedes, it is claimed, ability to perceive music at all, in fact to the new-born infant a loud noise is indistinguishable from a bright light. On the latter point it seems unwise to assume that even if the child makes a similar response to two different stimuli, the effect on the child's CNS is identical.

The effects of the indefinite listening of the infant is characterised by Vernon as 1. reflex, soothing or stimulating effects on the muscular activities of the organism, and 2. general euphoria and other pleasant or unpleasant organic sensations.

Accounts of very young children do usually refer to their being startled by loud noises and soothed by soft voices or music. Wing, for example, speaks of his daughters listening "with evident pleasure to all styles of music". It would be rash to claim too great an effect on the child's later emotional response to music for these early experiences. Wing points to the strong connection between the self-protective mechanism of the baby (in which sounds play an important part) and emotion. It seems likely that if music is early associated by the child with parental affection, the child will tend to grow up enjoying music. If his responses to little musical "tasks" receive the parents' praise, the child will probably be encouraged and an attitude of confidence (so important in dealing with music because of its dynamic and intangible nature) built up. The child with high innate capacity is most likely, of course, to perform the early tasks successfully. The less successful child would need to be treated with patience to avoid discouraging him.

The following table summarises some of the statistical data on responses to music and other auditory stimuli reported by Shinn and Shirley from the observations available to them.

Table. VI. Children's Earliest Responses to Music and Sounds

	SHINN (inc. Preyer)			SHIRLEY		
	n.	range (in weeks	median	n.	range (in weeks)	median
Listens to voice				21	3-8	4.0
Quietened by voice				15	2-11	5.0
Startled by sound				19	3-10	5.0
Pleasure at music	10	3-7	6.3			
Listens to music				20	3-19	9.0
Coos or stops crying at music				18	12-32	15.0
Sounds purposefully made by hand	10	11-23	15.5			
Vocal sounds purposefully made	12	9-26	16.0			
Looks in direction of sound	15	11-21	16.0			

To the above study may be added Haller's study (1932) of 19 children aged 3 to 5 weeks. Using an audiometer she attempted to classify responses to several different pitches and intensities into those indicative of discomfort and those interpreted as pleasure. Even when the babies were awake, comfortable and newly fed, positive responses were given to only 47% of the stimuli. In cases of doubt Haller preferred to record no response, so that this may be an underestimate. On the whole the higher pitched and louder tones tended to evoke more discomfort responses than the softer lower ones.

Considerable individual differences are apparent from the above table. These might be largely due to the different standards applied by the various observers (in nearly every case the mother). The accounts of individual children show the establishment of such an activity as looking in the direction of a sound to involve a period of maturation and learning. Shinn observed it incipient in her nephew in the 13th week, but not unmistakable till the 19th. Though Preyer's son moved his head in the direction of the sound when his father knocked on a mirror behind him no notice was taken of more distant sounds, such as a hand-organ in the garden, till the 16th week.

The table also shows that to the passive listening or diffuse responses of the nine week old baby more specialised and purposeful behaviours are gradually added. The earlier interest in sounds and music attempts to create sound by manipulating objects with the hand and by vocalizations are not, however, necessarily responses of a purely auditory nature. Unless Shinn's neice could see the noise-making process, sounds did not greatly interest her. In her own noise-making, ringing a bell or rapping things together, she did not seem to care so much for the sound itself as for the relation of process and result. This suggests an interest more embryonically scientific than musical. A similar comment might apply to Preyer's son who, at 10½ months, discovered by accident that the sound made by striking a plate with a spoon was dulled when he touched the plate with his other hand and then proceeded to experiment with the spoon in the other hand.

Spontaneous Musical Activities

Shinn is probably right to think that a very young child's interest in sound-making activities is due to interest in producing effects by self-activity rather than in filling his ear with sound. In Wing's view, all children are likely to gain pleasure in making a noise, largely due to the sense of command over his environment that the child gains thereby. Yet, in addition, there appears to be some genuine interest in sound for many children. Thus, Moorhead and Pond (1942) claim that the small child produces sound from anything and everything around him. And while he does this he listens - it is not an aimless occupation. Some sounds please him more than others; some he will discontinue quickly, others he will repeat many times. Music is for young children, primarily the discovery of sound. Their deepest interest is in tone-colour. When the young child "begins to use instruments for specific purposes (e.g. dramatic) he chooses the instrument whose timbre he considers most suitable".

In the Pillsbury Foundation School it was, of course, much easier for this interest in sounds to acquire musical significance than in an ordinary home or nursery school. Gesell and Ilg (1943) report that the 18 month old child is at least "very much aware of sounds such as bells, whistles, clocks" while the 4 year old "likes to experiment with instruments, especially combinations of notes" on the piano.

Moorhead and Pond (1941) distinguish two types of music produced by young children, a) chant and b) song.

Chant appears to evolve from speech. In fact, the first type of chant is merely heightened speech; its rhythm is that of speech, but it differs from speech in that the most important syllable is strongly accented melodically. The second type of chant has a definite rhythmic pattern to which the words may be forced to conform.

The distinguishing characteristics of the second type of chant is that it seems indifferent to melody; is rigidly rhythmic and closely associated with physical movement; it is repeated through rises in intensity and pitch till a climax is reached, then stops. A chant may be started by an individual but is most often sung in groups. It occurs when the child is free and happy and is immediate in emotional origin. Four procedures in melodic construction which are "absolutely fundamental to the child's musical concepts", as his chants reveal them, are quoted:

1. A falling minor third (probably slightly larger than a tempered minor third) after an accent;

2. An ascending, unaccented fourth preparatory to the accented upper note of the third a tone below it;

3. An appogiatura resolved downwards; and

4. (less frequent) An ascent of a tone to an accent followed by a descending perfect fourth.

The following is an example of a chant in its "final" form:

Other writers have reported on chanting among young children. Gesell and Ilg mention for the 2½ years old child spontaneous singing of the minor third to such phrases as 'coal man, coal truck'. At four the child "creates song during play - often teases others on a variation of the minor third". At eighteen months Shinn's niece began to amuse herself with a sort of tuneless chanting of syllables which became a regular expression of happiness while she played. From a monotone during the second year, this later grew more varied and rhythmic till it had quite a pleasing and musical effect, contrasting significantly with her reluctant and ridiculous efforts at civilised songs*. (Much of this spontaneous music-making was probably more in the nature of 'Song' (see below), rather than of 'Chant').

According to Moorhead and Pond (1941) Chant "is the most primitive musical art-form, for such it is _sui generis_, to be found amongst children and, indeed, amongst men in general. It is part of the living experience of primitive peoples everywhere, ...as a primitive, pagan, unsophisticated musical expression _arising from those things which the child feels instinctively to demand such expression_". Is Chant then to be considered a type of music making inborn in every human being? The Pillsbury report (1941) notes 150 chants collected over a period of four years, but does not state if certain children were usually the initiators, and the rest of the children were imitators. Even if each child at some time initiated a chant, this might have been due to imitation of chants previously heard from another child, or from a record. (At the Foundation the children had the opportunity of hearing Oriental as well as Western music and may have found the former easier to imitate). Among primitive peoples too there is, of course, a social environment and the child hears chanting from other members of his tribe or family. Cases of children growing up among animals appear to emit howls or guttural sounds rather than to produce chants (Anastasi, 1937, p.78

*She apparently outgrew her own 'compositions' as she grew more proficient at learning the songs which were sung to her.

Revesz (1953) then, would seem right to treat attempts to draw parallels between the child's musical utterances and the music of exotic races with the greatest caution till more careful investigations have been made.

Besides chants, children will produce songs of their own invention. In contrast to chants, "song is essentially produced by the child for himself". These experiments in melody are changed and developed as the child wishes. The rhythm is free and flexible and if accompanied on a drum the song may be at a different tempo. The melodies are not necessarily diatonic and most seem not to relate to any observable tonal centre or not to a tonal centre found in Western music. The melodies tend to progress by small steps, but long intervals are sometimes used to considerable dramatic purpose (Moorhead and Pond, 1942, p.14). In children with musical talent the singing of self-invented melodies that exhibit the first beginnings of musical form can occur "as early as the fourth year" (Revesz, 1953, p.173). In these melodies, Revesz continues, one finds uncertainty in general pitch, intervals, keys and motives, but some children reveal a sense of tonality.

These compositions of very young children are probably largely imitative rather than creative. For example, at Pillsbury, Jay (a boy of 4:7 years old) is reported to have "devoted himself to a prolonged period of exact repetition" of a Mexican recording he had heard several times. "He then attempted a more complicated pattern from the same recording, but was not able to establish it and returned to the first pattern for another long period of" exact repetition (Moorhead, Sandvik and Wight, 1951, p.21).

In the opinion of Moorhead and Pond (1942, p.19) the child's world of music is so wide that enforced conformity with the conventions of Western music before the child has sufficient background to see them in proper perspective is likely to hinder the growth of vital musical conceptual patterns. They claim that eventually "our children will tend to feel our system, which is continually being transformed and expanded, is closest to them... But their experience, knowledge and perceptive potentialities will be greater than if their experience had been confined to that system". It is difficult to assess the educational value of the Pillsbury type of experience (as opposed to its psychological interest) in the absence of evidence that would show whether children brought up in such a school do in fact end up with a wider appreciation of music than those who have been encouraged to listen to and sing a wide variety of "conventional" melodies (as advocated, for example, by Wing, 1941a, p.387) Possibly what really matters is that the child should grow up in an environment where music is valued and is attentively listened to by his parents, teachers and older children, and that he should hear music that is good of its kind.

Acquisition of Musical Skills - Melodic

The following table combines the observations of Wing of the appearance of various melodic skills in his daughters with the ages quoted by Shinn for her own niece and for other children.

Table VII Appearance of Various Melodic Skills in Young Children

Recognising a tune	9th month	Wing	1st child
	12th month	Wing	2nd child
	20th month	Tilley	2nd child
	21st month	Tilley	1st child
	28th month	Shinn's niece	
Reproducing a note correctly	9th month (singing correctly every note from piano)	Friedemann (cited by Preyer)	
	13th month (last note of a song)	Wing	1st child
	20th month	Wing	2nd child
	28th month	Tilley	
	Not till 4th year	Shinn's niece	
Repeating interval	8th month (notes of cuckoo clock)	Safford	
	14th month	Wing	1st child
Some memory for "general melodic shape"	16th-18th month	Wing	2 children
Singing a tune correctly	"Several songs" 15th month	Helliwell	
	16th month	Wing	1st child
	"Before they could talk"	Friedemann: 3 siblings	
	24th month	Wing	2nd child
	Nearly 3 years	Preyer, Daniels	
	Not till 4th year	Shinn's niece	

It must be rather difficult to judge how far a very young child really recognises a tune. Wing states that his daughter appeared to recognise such tunes as Pat-a-Cake by making the appropriate physical signs of clapping etc. That the response was to the melody rather than to the sound of the words is confirmed by the child being able to sing later on, before she could talk, a complete nursery rhyme with distorted words. By singing a song completely Wing meant with the steps and leaps in the right place though e.g. a fifth might be sung instead of a sixth.

As evidence of the early development of some differentiation between tunes and some memory for their general shape, Wing observed that some children who did not sing (probably because their parents did not sing to them) quickly learned to indicate which of certain known gramophone records they wished to hear from the colour of the label. This may certainly seem reasonable evidence of some memory for differences between tunes. However, apart from the limited number of records which could be distinguished solely by colour of label or size, it must have been difficult to be sure that what the child preferred depended on the melodic line, rather than rhythm, tempo etc.

The elder of the Wing children showed continual progress with age. Between 2 and 3 she could sing through the tunes of the Children's Overture with all its changes of key entirely without prompting. She evidently had a considerable memory for melody, as she would indicate a record she wanted to hear by singing its theme and could sing the second phrase of a tune, if an adult sang the first. At 3 years 7 months she sang through an Easter hymn which she had learned seven months previously (and had not heard or sung, to the knowledge of her parents, since then).

Valentine (1956) contrasted infants under 3 who could sing accurately a considerable number of simple tunes with his own five children's inability to sing reliably a tune at 7 or 8. Only one was able to do so even when adolescent; yet all his children heard a good deal of music at home, in church or in school.

Further evidence of the kind of melodic tasks which children between 2 and 5 can undertake comes from a number of studies of pre-school children, mostly concerned with how far such skills can be improved by training. The latter aspect of these investigations will be discussed on pp.253-4 below.

Gesell and Ilg recorded the following developmental stages:

2 years	Sings phrases of song, generally not on pitch.
2½ years	All of parts of several songs sung spontaneously at home or school.
3 years	Whole songs reproduced though generally not on pitch; can recognise several melodies; is beginning to match simple tunes.
4 years	A few can sing entire songs correctly.

Updegraff, Heileger and Learned (1938) obtained the following average scores from pre-school children, whose mean IQ was around 121, but who had had little training in sing-
ir

Table VIII

	Max. score	Ave.score at 3 n. = 16	Ave.score at 4 n. = 14	Av.scor at 5 n. = 36
Singing one note after it had been sung	9	6½	5	8
Singing an interval after it had been sung	12	7¾	6¾	10
Singing a phrase after it had been sung	14	-	10	-
Singing a phrase after it had been sung	29	-	-	13¼

Four trials were allowed for each item of the tests.

Many of the five year old children were able to make perfect scores at singing one note and an interval. Out of 1282 intervals sung by four year olds only 0.5 were in the wrong direction. The children's skill was not, however, too firmly established, as may be judged from the fact that they appeared unable to sing a note played on an instrument, though they were perfectly capable of reproducing it after it had been sung to them. Moreover, especially with the three year old group, performance was inconsistent. On one day their scores might be high, while on the following day they seemed unable to sing so well.

Twenty-three pre-school children, median age 4:5 and with a mean IQ of 123, were trained by Drexler (1938) for 15 periods of ¼ hour to sing two songs previously unknown to them. Six out of the 23 were then able to record into an Ediphone an absolutely accurate version of the songs.

The following table shows the percentage of boys and of girls who were able to learn to sing a scale at pre-school ages, as reported by Monroe (1903) from the investigations of his students (who may have applied slightly different standards of judgment):

Table IXa

Ages	n.	Boys	Girls
2 to 3	38	29%	49%
3 to 4	64	31%	54%
4 to 5	46	34%	59%
5 to 6	12	40%	71%

Some data were also collected on the children's memory for the scale and for songs learned, after two weeks:

Table IXb

Ages	Boys		Girls	
	Scale	Songs	Scale	Songs
2 to 3	19%	43%	23%	59%
3 to 4	27%	50%	33%	61%
4 to 5	29%	47%	45%	62%
5 to 6	40%	50%	57%	71%

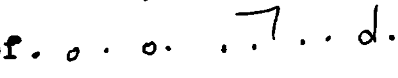
However, Burroughs and Morris found that the "average" child of 13 (see p. 82 above) could manage to sing less than half of a 12 note tune accurately, even after 8 trials.

Acquisition of Musical Skills - Rhythmic

As far as time and rhythm are concerned, there appears to be some difference of opinion as to whether these develop before or after melodic skills or independently.

Revesz considers that in the period between the second and fourth years "music and movement go together and cannot be divorced one from the other. In this period, for biological reasons, rhythm seems more important than melody" (Revesz, 1953, p.172). If harmony is the highest form of musical perception, according to Podolsky (1954 cited Taylor and Paperte, 1958) rhythmic perception is the initial stage, with melodic coming in between.

In Wing's opinion, however, the first aspect of music to develop is, in the case of many children, melodic shape. Wing agrees that the young child delights in physical activity but doubts its value from a purely musical point of view. His own daughter, when she could reproduce a tune perfectly as regards melody, tended to shorten the longer notes considerably, through a lack of patience and rhythmic sensitivity. (Many much older children make exactly the same mistake when they come to learn an instrument). Though her singing gradually became more rhythmic, at the age of 3½ or 4 many songs still had notes shortened or lengthened without regard to the regularity of the beat. For example,

 would be sung instead of 

Further, from his observations of children engaged in music and movement in schools, and in spontaneous play, Wing reported that though they frequently sing for example "Ring-a-Roses" quite well in tune, they do not normally skip or walk in time with the music.

It is extremely difficult to judge if children walking or marching to music are in fact keeping in time. Heinlein (1929) reported that three experienced musicians playing from memory and watching children move "in time" with the music tended to fit their timing to the movements of the children rather than vice versa. Heinlein then asked eight children aged 3 to 5 to walk "in time to music" on a runway which had electric contacts designed to record their steps. The beat of the music was recorded at the same time. Only one of the eight subjects showed any degree of co-ordination between the walking movements and the musical beat. This boy was the child who had appeared during the preliminary training period the least able to perform the task. It is stated of another boy who had appeared extremely responsive that though he appeared much stimulated to motor activity by the music not once did his walking synchronise with the musical beat.

These results were confirmed by Jersild and Bienstock (1935) who used photographic methods of recording how exactly pre-school children could keep time in walking, or with hand movements. The following were the average scores out of a possible 200: at 2 years, 41.8; 3 years 56.3; 4 years 82.3 and at 5 years 97.5. Seventeen adults earned an average score of 174, some making perfect scores. Jersild and Bienstock found that their subjective ratings of the children's accuracy in keeping time were quite untrustworthy when compared with the objective records.

Certainly some caution is required in looking at the reports of ages at which various children are said to be able to keep time to music by movements. At 12 months Chapman's child could keep time to music and by his 20th month "could keep the polka step for six measures at a time". Twelve months is given by Wells, a musician herself, as the age at which her child could keep time (see Shinn, 1907, p.191). By about the end of his second year, Preyer's son could "beat time with tolerable correctness " while trying to sing over a song sung to him. Moore's child at the 22nd month and Tilley's at the 32nd would fill out the rhythm and accent correctly when the words of a song had been forgotten. Shinn's niece could not be taught at any time in the first three years to keep time to music. Gesell states that three year olds may be expected to "gallop, jump, walk and run in fairly good time to music".

Il'ina (1961) asked his 130 subjects, aged 3 to 11, to move to music played in whatever way the music suggested. The older children were better able to correct themselves and change with the music. The younger children tended to respond to changes in intensity with changes of tempo.

A much simpler task from the child's point of view, as well as from the observer's, is producing a regular monotonous beat of his own. The first musical attempts of a child are characterised by a "regular, unaccented beating" probably physical in origin (Moorhead and Pond, 1942, p.14). Thus it is recorded of Carl, aged 3:8 who attended the Pillsbury School for four months, "he reverted to the usual regular beat, perfectly even, fast and insistent". Roy, aged 4:2, "used a regularly spaced series of beats, with occasional pauses, moving arm and hand with pendulum-like regularity. When first he marched with a drum, he walked with regular steps, beating the drum to agree, the drum accent coinciding with the right foot" (Moorhead, Sandvik and Wight, 1951). A little later, the child begins to introduce "accentuation within the regular series of beats which he has set up, such accentuation being most often irregular. His rhythms, therefore, are not repetitive nor necessarily symmetrical, but their structure almost inevitably is related to the fundamental pulsation" (Moorhead and Pond, 1942, p.15).

Such an account of the rhythmic capacities of young children is not inconsistent with their finding difficulty in synchronising a beat with the beat of music played by others. In fact, Moorhead and Pond further remark (p.16) that "The child has great ability to maintain his own rhythmic concepts against all competition and interference. When he plays simultaneously with other children each child is likely to go his own way. But in a long established, well-integrated group the children's music is likely to assume the characteristics of a kind of rhythmic polyphony based upon the fundamental co-ordinating pulsation which they feel". Simultaneous grouping of 2 against 3 is frequently found (as is the case with African drummers).

The difficulty the very young child finds in conforming to a time pattern, or a beat, or a pitch outside himself may be part of the general ego-centric perspective of the very young. It might then seem possible that precisely because (in Wing's words) "Of all musical capacities the ability to recognise rhythm is probably the most elementary; it develops early, is the most widely diffuse" (Wing, 1941, p.349) that rhythm seems more resistant to training or to environmental influences. Better motor co-ordination may be needed to make a limb synchronise with a pulse than to make the voice conform to a pitch. This is suggested by Farnsworth (1958, p.185) as a reason for the more tonal abilities appearing in the child at an earlier age than do the rhythmic. Once established, however, their development may proceed more quickly; for appreciation of rhythm scores reach a higher-than-chance level slightly earlier than does appreciation of harmony, intensity and phrasing (Wing, 1941a, p.394).

According to Bentley's researches (1963), by the age of 8 the average child has reached a stage of readiness for making analytical judgments on the tonal and rhythmic aspects of melody. He can discriminate pitch differences of a ¼ tone by 8 and a $\frac{1}{8}$ tone by 10. The rote memorisation of a frequently repeated melody may be too unchallenging. If the naming of sounds, for example, is neglected when the children are ready for it, interest may decrease. By 12 the optimum period for learning to name sounds may have past.

Acquisition of Musical Skills - Harmony

It seems to be generally agreed that young children have no great appreciation of harmony, finding "every harmonic accompaniment equally good, whether consonant or dissonant. Usually they do not even notice the difference between major and minor" (Revesz, 1953, p.175). Thus, Rupp's two children aged 6-8, were equally content with a minor or a major ending to a tune played to them (Rupp, 1915). Valentine concluded from experiments on some 200 elementary school children aged 6 to 14 that (1) no appreciable preference for concords before discords is discernible before the (average) age of nine, but at this age a very marked advance takes place.(2)It is not till we reach the age of eleven that we find that the discords ... are on the average more displeasing than pleasing ...(3) At twelve and thirteen ... we suddenly find changes which result in an order of preference for the various intervals which is almost exactly the same as that given by adults" (Valentine, 1919, pp.105-6). However, girls at a preparatory school often were three years in advance of the elementary school children (see further p.276).

Wing considers that very young children find harmony a distraction from the melodic line. Between 8 and 11 the child develops some sensitivity to effects of harmony, as shown by results of cadence and discord tests. But only by the age of 11 can children of average musical ability give answers to his fifth test that are much above the level of chance (Wing, 1941a, p.493). Bentley (1963) also found that the average child did not appear to be ready for work involving chord analysis before 11.

According to Franklin an ear for tonality begins to be stabilised first between 6-9 years. This is preceded by a stage where one can speak of an ear for pitch and an ear for consonance and dissonance but not for simultaneous horizontal and vertical listening (Franklin, 1956, pp.58-9). This suggests that an appreciation of harmony does not develop till the child is capable of attending to a bass as well as to a melody. At an earlier stage still "to combine concepts of timbre and rhythm seems to be somewhat too complex for the small child" (Moorhead and Pond, 1942, p.17). When the child was excited about a rhythm he would pick up e.g. the nearest drum (whereas he would normally choose an instrument for its timbre with some care).

This may suggest a comparison with the findings of Piagetian experiments which showed that not till the age of 6 or 7 does the ability to examine two judgments, as opposed to two objects, simultaneously develop (Lunzer, 1960). Though musical ability would seem to be rather highly specific (see Chapter III), certain parallels with the child's general development could possibly be drawn. As far as the writer knows, no one has yet attempted to compare the performances of children at the various "stages" described by Piaget with equivalent musical tasks. Ross (1959) attempted to investigate the ability of 173 junior and first year secondary-modern children to reason about sound in situations covering the relations of sound and movement, frequency and length, length and pitch etc. Not surprisingly, she found most of the children understood little about sound, beyond that it was somehow connected with movement. In any case, such a study has more connection with acoustics than with music.

There may seem to be some parallel between Wing's findings that appreciation as measured by his last four tests is not well developed in the average child before 11 and M. D. Vernon's (1960) conclusion that the normal child does not fully understand pictures and interpret them as a whole till about the same age. This does not, of course, mean that no aesthetic appreciation occurs among younger children within their limited cognitive powers, e.g. of a melody, if not of multi-part music. Burt (1945, p.292), in fact, found that some of the youngest children (under 8) came very near to the judgment of experts on a picture ranking test and concluded that there might be some truth in the idea that as people grow up their artistic vision declines, i.e. they see what they know to be there, not what is there to be seen.

Scores on musical ability tests appear to increase with age up to 17 in the case of the Wing battery, up to 23 in the case of Drake's memory test. Wing (1948, p.77) considered that improvement with age was largely due to the natural growth of innate aptitude, since it continued after school music lessons had ceased and appeared to be little affected by giving up or commencing the study of an instrument. Bentley (1963), too, attributed the increase in scores on his tests between the ages of 8 and 12 mainly to maturation, since most of his subjects had no music lessons apart from their school music lessons.

Conclusions

The material in this chapter will be further discussed in the next chapter, after a brief consideration of the psychology of perception and of its application to music. The only conclusions to be offered for the moment relate to conditions of the early environment which would appear to favour the development of whatever musical capacity the child may possess.

The first essential condition is, of course, the existence in the home (or nursery school) of opportunities to hear good music. It is no doubt highly desirable that some of this music should be produced by a parent or other person of whom the child is fond. But if the parents cannot play or sing, they can at least try to set a good example of listening attentively, and of valuing music and musicians.

The child should be encouraged to make his own music. Considerations of expense would make the foundation of schools with facilities such as Pillsbury impracticable. Children might be encouraged to experiment with their own voices and the other sound-producing possibilities of their surroundings within the limits of the tolerance of adults within ear-shot. As Mursell and Glenn (1931) suggest, the child's interest in and love of tone could be the first growing point of his musical life - he can be encouraged to enjoy producing and listening to beautiful tone quality.

Possibly what is most important of all in the earlier years is that the child should come to think of music as a joyful activity.

CHAPTER V

THEORIES OF PERCEPTION AND THEIR APPLICATION TO MUSIC

Most of the research into perception has been concerned with visual perception. But "it can be assumed that perception in other sense modes does not depend on fundamentally different principles" (Hebb, 1949, p.16).

Two different answers have been given to the question of what is directly perceptible in a perceived object. The empiricistic answer is that the perceptive object consists primarily of elements out of which a complex whole is built up. The structural elements continue to exist in the aggregate; by a process of learning they are seen to be a logical whole. The answer of the Gestalt psychologists, on the other hand, is that an object appears as a whole, directly and immediately, the parts merging wholly in the total impression. While empiricistic theories emphasise the role of learning, Gestalt theories stress the role of innate organising processes (Zuckerman and Rock, 1957).

Hebb (1949) has sought to formulate a theory of perception which would retain some of the more valuable parts of Gestalt theory while taking fuller account of the importance of learning.

His argument is largely based on the evidence collected by Senden on the vision of the congenitally blind given sight by surgical operation after the patient was old enough to talk and describe what he saw. Hebb stresses the importance of Senden's monograph as containing "the only existent evidence concerning the course taken by the early development of human perception" and which appears to be confirmed by the work of Riesen who reared chimpanzees in darkness to an age when the normal chimpanzee makes an effective use of vision. Hebb considers this type of evidence shows that even quite simple diagrams or figures such as a square or a cube are <u>not</u> perceived directly as distinctive wholes without need of any learning process and without a prior recognition of the several parts of the figure.

Hebb distinguishes between the conceptions of (1) a primitive, sensorily determined unity, (2) a non-sensory unity, affected by experience, and (3) the identity (also affected by experience) of a perceived figure.

Hebb defines the primitive unity of a figure as referring to that unity and segregation from the background which seems to be a direct product of the pattern of sensory excitation and the inherited characteristic of the nervous system on which it acts. This innate figure-ground mechanism may include some perception of groupings.

The non-sensory figure-ground organisation occurs whenever the subject responds selectively to a limited part of a homogenous area, for example, "the corner of a room". It is affected by experience and is not inevitable in any perception, though in most perceptions both sensory and non-sensory factors affect figure-ground organisation.

A figure is perceived as having identity when it is seen immediately as similar to some figures and dissimilar to others, and when it can be readily associated with other objects or with some action. A figure without identity is recalled with great difficulty.

Referring to Senden's evidence, Hebb shows that as soon as the patient can see he can perceive a single coherent object such as a square as distinct from a background and may see a difference between two such figures shown together, but the differences are not remembered. The most intelligent and best-motivated patient has to seek corners painstakingly to distinguish a triangle from a circle. The shortest time in which a patient approximated to normal perception, even when learning was confined to a small number of objects, seems to have been about a month.

Colour has been found to dominate form persistently in the first vision of these patients. Perceptual learning in man proceeds gradually from the dominance of colour through a period of separate attention to each part of a figure to the identification of a whole as a whole: an apparently simultaneous instead of a serial apprehension.

Senden's evidence and Hebb's interpretation have been criticized, for example by Wertheimer (1951), on these counts:

1. The sources of material were unreliable. This

is partly true, inevitably, as there were 66 cases, 10 earlier than 1800, but there is considerable unanimity among the writers who were often the surgeons concerned with the operatio and some of them were evidently not aware of the reports made by others.

2. The difficulties confronting the patients when sight was first recovered included acute dazzle, functional narrowing of the visual field and cramp of the eye muscles. It is hard to know how much weight to place on these factors. In some cases they quickly disappeared, while the perceptual difficulties persisted much longer. But they may have caused a loss of confidence in the patient which lasted even after they had cleared up.

3. The evidence is difficult to interpret. Learning to distinguish colours would appear not quite so easy, nor learning to identify shapes so difficult as Senden and Hebb would make out. The original investigators may also have misinterpreted the patients' reactions. (Painstaking though most of them were, few were professional teachers and their choice of tasks for their patients may not have been very suitable).

Further reservations which should be borne in mind in seeking to base a theory of the development of perception in the newly born on such material are:

Hebb appears to underestimate the emotional "crisis" which the newly sighted pass through as they begin to realise how much they have to learn. But Senden (1960) makes clear that the fatigue caused by the abundance of impressions, the awareness of the size and difficulty of the task and a sense of being under pressure to learn all bore especially hard on the patients, many of whom were manifestly weak personalities. When they realised that they were at a serious disadvantage compared with the normal people with whom they would soon be expected to compete, their blindness seemed a happier and more peaceful state.

Accustomed to receiving sensory impressions in succession through hearing and touch, they had now to deal with perceptions which arrived simultaneously (Senden, 1960). Over a much longer period than the newly born, they had been dealing with successive perceptions. They may thus have acquired a much greater tendency to scan the outline of objects in order to identify them than is the case with the infant. Hebb's emphasis on the need to recognise the several parts of a figure before it can be identified might seem less applicable, therefore, to the newly born.

In spite of these criticisms the evidence would appear to be sufficiently valid to require explanation in any comprehensive theory of perception.

As Hebb points out, at birth an intrinsic organisation of co-ordinated activity is already in existence. (This would deal with the Gestalt objection to an empiricistic view of perception: that a completely diffuse field <u>never</u> would become organised and that perceptual organisation must occur before experience can exert any influence). Hebb considers two possible explanations of congenital intrinsic organisation: (1) that there are "pacemakers" with the inherent property of dominating other neural cells and producing synchronous firing, and (2) that the synchrony is "learned" - established in utero as a result of the neural activity itself. The comparatively slow change of the infant's EEG towards the adult pattern and the lack of sharp discontinuity between the two extremes suggest to Hebb that the latter is more likely. However, the study of brain physiology has tended to emphasise the importance of genetic factors, e.g. in the age of development of the (adult) alpha rhythms. But crucial observations had not been reported by 1953 and even those on identical twins were not conclusive (Grey Walter, 1953).

Hebb, then, tends to stress the importance of learning, while agreeing that a figure can be perceived as distinct from ground without prior experience, provided that it is simple. He thereby considerably limits the possibilities of unlearned perception, since there are few simple figures. However impressive the part played by experience may seem in identifying figures and in selective response to parts of a visual field, heredity would seem to be involved even in the latter. To some extent the ability to select would appear to depend on mechanisms in the brain which, for example, "act like traffic cops for incoming information and actually damp down and modify the action of the receptors themselves"

(Tanner et al., 1960). These mechanisms sound as if they may be part of the inherent equipment of the species and, perhaps in individually varying degrees, of the individual organism.

Theories of Perception as Applied to Music

Psychologists interested in music have tended to favour a Gestalt explanation of musical perception. For example, Revesz writes "The melody consists of single notes, just as a figure is made up of lines. However, the final product that is directly perceptible is a functioning whole, an individuality that cannot be apprehended from the parts... The melodic-rhythmic impression of a musical motive remains the same" even when the tune is transposed, while the change of a single note may change the entire character of a melody (Revesz, 1953, p.93). As von Ehrenfels pointed out, to reverse a melody would be to destroy it (Mainwaring 1954, p.611). Similarly, with chords, Vernon found subjects could recognise chords as a whole, even when they could not name the notes, or even say how many notes were being played (Vernon, 1934).

K. Gordon (1917) experimented with playing five melodies backwards to 20 adults, classified as musical or unmusical according to their performance at singing back the melodies in their original form. The attempts of the musical subjects to reproduce the "nonsense" melodies were as might be expected more affected by the change than those of the unmusical.

However, eventually the "nonsense" music came to sound like tunes. Emerson obtained a comparable result by constructing "microscopic melodies" with intervals smaller than a semitone. Though the sequences seemed to possess little tonality in the Western sense, his subjects learned to regard these unusual patterns as unified, and to develop certain expectancies concerning them (Emerson, 1906).

Such experiments could be interpreted in two ways; as illustrating either a human inborn tendency to see patterns even in unusual contexts, or the importance of experience in musical perception.

In Vernon's words "every kind of perception which is in the least musical ... requires extensive training and experience" (Vernon, 1934, p. 269). Even if tunes are perceived as a whole, "what we perceive <u>from</u> the whole depends on previous experience and present interest" (Mainwaring, 1954, p.611). Revesz (1953) agrees that before musical figures can be grasped as homogenous Gestalts they must belong to "the framework of our own occidental musical system, music that we know and with which we are thoroughly familiar. In listening to exotic music we must first ... familiarise ourselves with the structure, before we are in a position to grasp oriental music as a homogenous gestalt" (p.94). Similarly in 'This Modern Music', Abraham (1955) recommends the listener who wishes to learn to appreciate, for example, the twelve-tone system, to play over as much music written in that idiom as possible in order to accustom his ear to the sound.

On the other hand, the extent to which individuals can perceive patterns in music differs with the individual. According to Revesz (1953) a totally unmusical person "views a melody as a mere sum total of notes" and fails to perceive it as a whole pattern. Gordon's musical subjects were much more efficient at singing back the melodies backwards than the unmusical were at reproducing them when played forwards. Wing (1941a, p.293) found that his more musical subjects tended to use a Gestalt approach to his tests, but many individuals habitually, or on certain occasions, also adopted a more analytical approach.

What is true of the experienced listener is not necessarily true of the very young child's perception of music. The simplest auditory equivalent of Hebb's "primitive sensorily determined unity" would seem to be a noise or musical tone sounded against a background of silence (or the multiplicity of indeterminate background noises which passes for silence). At as early an age as one week, one infant was reported to have stopped feeding to listen to the sound of a distant gong (Forbes and Forbes, 1927). It is difficult to judge from, for example, Haller's investigation mentioned above (Chapter IV, p. 139), how far the very young are able to distinguish between louder and softer or higher and lower sounds. There were indications of individual differences in response. One child, said to have musical parents, showed great sensitivity to sounds of all kinds. Another who was quite unresponsive to the loudest tones of the audiometer showed great interest in the footsteps of the nurse when hungry!

If timbre or "tone colour" of sounds can be considered the auditory equivalent of colour, some perception of timbre appears to develop early (see p. 141 above), though it would be hard to assess if very young children tend to rely on it to distinguish between sounds, as many of the newly sighted try to use colour to identify shapes when they first gain their sight. According to Belaiew-Exemplarsky's results (cited Mursell and Glenn, 1931, p.23) her 29 subjects, children aged between 6.5 to 7.5 years, still found their greatest joy in music from timbre or beautiful tone colour.

Perhaps the musically most important gestalt in the child's environment is the tune. Even when the infant is awake and listening, the ephemeral nature of a tune, limited in time by silence before and after, must make "definite perception" difficult. It is not surprising that even evidently very musical children do not begin to recognise tunes before the 8th or 9th month (see pp.147-8 above). (It seems unlikely that tunes are recognised at an earlier age when the baby is unable to make any overt sign of having identified them. Even a human face is not recognised before about the sixth month). In the Gestalt view the child who hears a tune repeats it as a tune with no conscious knowledge either of its constituent intervals or any other of its analysable characteristics. Wing's account of the earliest efforts of his daughters to sing a complete tune seems to confirm this. It was the general melodic shape rather than the longest or most prominent notes (as would have been expected if knowledge of the tune was being built up from its elements) that was learned first. According to Monroe's report (see p. 151 above), the song was recalled better than the scale. This, however, may have been due to the words of the song having captured the children's interest.

The length of the gestalt which a young child can reproduce varies from a single note or interval to a phrase or song (see pp.147-151above), but the attempt to reproduce the whole seems to be made, even if the pitch and time are not accurate. Children usually find a faster tune easier to learn. A jazz dance tune is also unexacting because the gestalt is very small and frequently repeated.

The ability to organise notes into a pattern is, of course, a great aid to recall and of particular importance in a dynamic art like music. Man as a species may be a pattern-making and a pattern-seeking animal (Grey Walter, 1953). But there seems to be great individual differences in pattern perception as applied specifically to music. As Bruno Walter (1961) remarks, everyone must be musical "by nature in a limited sense" but man's elementary gift of music "is as little guarantee of a specific musical talent as is speaking of a poetic disposition".

The human tendency to perceive patterns may seem even more closely connected with the rhythmic side of music than with melody. Seashore considered 'subjective rhythm' (the tendency to organise a series of uniform clicks spaced at equal intervals in time into regularly accented groups) to be an inherent characteristic of the organism. Grey Walter (1953) wrote "The reader can test the brain's suggestibility and its affinity to rhythm. Listen to the regular ticking of a clock, and note how long it takes for the unaccented sequence to resolve itself into groups of two, three or four ticks. This affinity to rhythm, the close correlation between external patterns of sound and those within the brain, suggests one reason why loss of hearing ... is so hard to bear". It is difficult, however, to assess the extent to which this ability is acquired from the environment, from hearing music with regularly accented beats or even from "suggestibility", i.e. hearing what one expects to hear. Mainwaring (1954) implies that the "natural" rhythmic Gestalt of a duple unit is literally learned in the cradle through the baby being rocked, or, he suggests it may be due to such natural rhythmic movements as walking being duple in quality. Moorhead and Pond, however, consider the typical beat of the very young child to be an even, monotonous, unaccented beat. The ability to produce a freer, more musical beat seemed a later development. (It might still, of course, depend on maturation rather than experience).

The observations of Moorhead and Pond might suggest that ability to keep up a fairly steady beat is a rather widely distributed, if not universal, human capacity. Further, evidence may seem to be provided by Pampiglione's experiment which showed that an anticipatory response to a regularly recurring stimulus could be obtained even from sleeping subjects. Pampiglione evoked a K-complex of the EEG (a mechanism which evidently protects the sleeper from arousal) by a non-specific stimulus in a rhythmic fashion every 10 seconds. When the stimulus was stopped, the K-complex response continued regularly every 10 seconds for some time (Tanner et al, 1956, p.240).

But if a regular pulse is so deep-seated or so easily induced in human beings, why do many children have difficulty in maintaining a steady pulse when learning an instrument? Why do adults often dance out of step to "strict tempo" music? Why should Drake think it worthwhile to construct a test to measure ability to maintain a steady beat at different speeds? (see Chapter I).

No doubt part of the difficulty may be due to lack of muscular control or of confidence, or inattention, or technical difficulties. For example, a child may begin to play at the speed he feels is the right tempo for the piece, but which is too fast for the technically difficult passages. However, even when all such technical difficulties have been mastered, the pulse may still remain irregular (in an inartistic sense, not in the sense of rubato or subtle variations superimposed on a steady beat for aesthetic reasons) Any inherent tendency towards a steady pulse, then, does not necessarily function in music. The capacity to maintain a steady beat in music might, however, be inborn in the individual. This is suggested by the low correlation of Drake's test with age (r. = .14) and the small differences in the norms for non-music, as compared with music, students (i.e. those with five years or more training). However, the 598 subjects for whom the correlation with age was calculated were aged 8 to 38. Differences due to age might be found in subjects younger than 8.

Reference has already been made in Chapter IV, p.140 et se to the close connection between motor activity and sound-producing activity, even in the child's earliest attempts to manipulate and explore the sound-making possibilities of its environment. Vernon (1931, p.126) emphasises the importance of the kinaesthetic side of musical perception, stating that "as soon as the listener becomes consciously aware of temporal (or pitch) motions in the music itself, external to himself, the response seems to become primarily (though by no means wholly) a kinaesthetic or muscular one". Vernon quotes Bingham's conclusion, from measurements of certain muscular contractions in listening, that attention to simple melodies always involves minute adjustments in the body and Weld's evidence, based on introspective and experimental data, from which he concludes that the objectification by the listener of any relational aspect of the music was invariably dependent on some corresponding muscular movement. To this might be added Mainwaring's demonstration of the importance of kinaesthetic factors in the recall of musical experience. An experienced singer was told to avoid singing a hymn tune to herself while it was being played to her. After the seventh playing she could sing only the first, second and last bars. Two days later her performance from memory was similar. When allowed to sing to herself during the playing of a second hymn tune, she learned it rapidly and was able to recall it with accuracy (Mainwaring, 1933, p.289). The last example could perhaps be interpreted as much in terms of disruption of the singer's habit of singing a new tune to herself, as in showing the necessity of a kinaesthetic response for accurate recall.

Though some of the importance of motor response in musical perception in the case of experienced listeners might be attributed to habit, the ability to reproduce a tune by singing or playing is extremely important in musical developmen Once a child can sing a tune for himself and repeat it at will, he has gone a long way towards mastering the ephemeral nature of music. He is like a cinema-goer who has gained control of the projector and is no longer dependent on grasping the passing stimuli. Il'ina (1959) attempted to investigate to what degree motor vocal reactions participate in the formation of auditory conceptions of the young child. At least in the case of his 30 musically backward pre-school subjects, he concluded that they were of considerable importance.

These remarks apply only to specifically musical motor responses. There is no special relationship between generalised motor activities and musical perception. Hissem (1933), for example, observed no significant connection between a child's tendency to sing and his tendency to laugh or engage in physical activity. However, taking part in some kind of motor activity was often found to lead to spontaneous music making by children (Moorhouse and Pond, 1941). The most frequently occurring occasion for 'Chant' at Pillsbury was motor activity of some sort (44 occasions out of 135).

The general conclusion of this and the last chapter is that musical perception develops gradually even when in contact with a favourable environment. However, there appears to be good evidence of individual differences of initial capacity to make use of environmental experience. Individual differences particularly with reference to cases of unusual musical talent, e.g. prodigies and geniuses, will be further discussed in Chapter VII.

CHAPTER VI

METHODS OF GENETIC STUDY

Introduction

In this chapter methods of genetic study, including the twin method used in Part Two of the present investigation, are briefly discussed. Some reference is made to results obtained from research into the inheritance of intelligence. This area has been much more extensively investigated than musical ability and the results may provide some basis of comparison.

Methods of Study

There are essentially two methods of trying to determine the extent and nature of hereditary influences in human traits or abilities.

One is to attempt to look for Mendelian units on genes. Under reasonably constant environmental conditions such traits will be passed on from parent to child in an all-or-nothing fashion and in accordance with laws governing dominance and recessiveness in genes. The number of psychological traits traceable as yet to single genes is "regrettably small" (Cattell, 1950, p.122). In most cases complications of two sorts are found:

1) there may be two or more different genes which produce identical, or seemingly identical effects;

2) the same gene may have different effects in different individuals or different environments. This may be due to variations in the penetrance of a gene (i.e. the frequency with which it shows any effect) or to environmental conditions modifying its expression.

Characteristics dependent on dominant genes will run in families, recurring generation after generation, as they may be passed on through only one parent. The degree to which they are manifest in any given individual may, however, vary. Traits determined by recessive genes cannot be identified by following them through several generations, since they usually occur suddenly in a lineage, as the result of the mating of parents with similar genes. The parents and the children of the person affected rarely show the recessive trait, but it also appears in about 1:3 of the affected person's siblings.

With all-or-nothing traits, especially if they produce noticeable, clear-cut effects, it is appropriate to study records of their appearance in families over several generations and to work out the Mendelian mechanisms involved.

However, the greater part of the variation in normal human populations appears to be continuous* and it is

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*Carter (1962, p.92) demonstrated how two pairs of genes and a small allowance for environmental factors could theoretically produce a normal distribution, but a number of genes is usually postulated to account for most human characteristics.

necessary to have recourse to the second method of investigating hereditary determination, i.e. to attempt to state what fraction of the observed scatter, the variance, is due to differences in heredity and what fraction to environmental differences. Having used as accurate a measure of the ability or trait to be studied as possible, the resemblance of relatives, reared together and apart, may be compared with those found among unrelated people reared together and apart. An ideal comparison would be that of identical twins reared apart with random members of the community (Cattell, 1950, p.125). However, such twins are rare. Newman, Freeman and Holzinger (1937) had difficulty in assembling 19 pairs. Other single cases were reported over the years. Shields (1962), however, was able to investigate 44 pairs and also to compare them with matched groups of identical twins reared in the same home. An intensive study of twins brought up apart is currently proceeding in Denmark.

A more readily available comparison is provided by identical and fraternal twins. Monozygotic (MZ) twins, who arise from a single fertilized ovum, have identical genetic patterns, while dizygotic (DZ) twins spring from separate ova which happen to be fertilized at the same time and are genetically no more alike than ordinary siblings. However, since DZ twins share the same prenatal environment and are born at the same time, they tend to be more closely associated than siblings. Identical twins, on the other hand, may acquire differences between conception and birth due e.g. to inequality of maternal blood supply or to lateral inversion (mirror-imaging). Moreover, monozygotic twins are particularly liable to be treated alike by their parents and friends, tend to go around together and may be thought to influence one another in various ways. Despite these limitations, from a comparison of the average resemblance between MZ and DZ twins one can tell whether or not heredity is of importance for a particular characteristic; and can sometimes estimate how important it is compared with general environmental conditions (Shields, 1962). Correlations of over .9 for intelligence have been reported for identical twins brought up together (Newman et al, 1937; Burt, 1943). For the intelligence of fraternal twins Newman found a coefficient of .640 and Burt one of .526. Rather lower correlations were reported for MZ twins by Blewett (1954) and by Shields (1962) - .76 in both cases. In fact Shields found practically the same correlation for his control MZ pairs (n. = 34) as for his sample of identical twins brought up apart (r. = .77, n. 37). Newman obtained a correlation of .67 with his 19 identicals reared apart. This might have been partly due to their educational differences being greater than in the British study.

The validity of studies comparing MZ with DZ twins depends on the accuracy with which the two types can be identified. "A clear difference between a pair in any one purely hereditary character such as one of the blood groups, will be sufficient to show that the pair must be dizygotic" (Shields, 1962). No similarity in any single trait normally available has so far been shown to be sufficient on its own to prove that a pair is monozygotic. The most identical looking pair might theoretically be dizygotic, even if the probability is in some cases very remote. The onus is on finding some feature which will establish dizygosity. If this cannot be done after careful investigation a pair can be classified as monozygotic with only a small likelihood of a mistake. Careful comparison of the appearance of a pair side by side, paying attention to colour, texture and distribution of the hair, the colour of the eyes, the shape of the features, the teeth, size and shape of hands and fingers, will enable one to distinguish a very high proportion of the DZ pairs. "Furthermore, a total impression has its own value, especially in picking out the MZ pairs ... A history of a pair of twins having been so alike that they were frequently mistaken for one another weighs more heavily in favour of monozygosity than any other single item of evidence" (Shields, 1962, p.35).

Of objective tests, blood-grouping is regarded as by far the best. Using two serum groups as well as blood groups Juel- Nielson, Nielson and Heurge (cited by Shields 1962) calculate that an exact diagnosis can be made in about 98% of all DZ twins. Finger-prints and the ability to taste phenylthiocarbamide are other useful objective measures, while in the Michigan Twin Study iris photography and head X-rays were also used, (Vandenberg, 1956). Vandenberg claimed to have diagnosed the type of twin with about 97% certainty, while Eysenck and Prell (1951) found only 6 out of 50 pairs whose zygosity called for further investigation.

The results of comparing identical with fraternal twins are sometimes expressed in terms of h^2, a statistic devised by Holzinger as a measure of the proportion of the variance of a trait in a given population that is due to heredity as opposed to environment. Holzinger's formula is

$$h^2 = \frac{rMZ - rDZ}{1 - rDZ}$$

where r is the intra-class correlation for MZ or like-sexed DZ twins. (An intra-class correlation is calculated by entering each score twice on the scattergram, the co-ordinates of the entries being the same numbers, their order being reversed (Newman, 1937)). Such a comparison minimizes the variation due to birth rank, age of mother and sex. But it does not take into account inter-family environmental variation; it assumes that the environments of MZ and DZ twins can be regarded as equivalent; and it does not take into account any interaction between heredity and environment. These underlying assumptions do not always hold and h^2 is also very sensitive to small numbers.

Correlations between other relatives do not enable the ext nt of heredity to be estimated as precisely as with twins.

The closer the genetic relationship the greater are the chances of the members of a family sharing the same home and social environment for long periods. Moreover, it may be difficult to find a test suitable for both adults and children. The results of testing siblings may be affected by differences in the test norms applicable to their differing age levels (cf. Vernon, 1960). However, such comparisons do provide some evidence on the extent of the genetic control of a trait. It may, also, be sometimes possible to deduce some information on the mode of inheritance from the study of family resemblances

The resemblances found between relatives depend on the number of genes they are likely to have in common. A father and son have, apart from the genes on the X chromosome (see p. 187), half of their genes in common because of their relationship. A pair of brothers may have half their genes in common or they may have fewer, since, for each chromosome pair of their two parents, it is an even chance whether the brothers receive the same chromosome or a different one, but the deviations will tend to be equal on each side of a half and the average will tend to be a half. The correlation between brothers can, therefore, be expected to be much the same as that for father and sons (Carter, 1962, p.113). Correlations of about .5 have been reported both between parents and children, and between siblings (Vernon, 1960). (Cattell, however, considers that the average of the children's correlation with the average of the parents (midparental) scores may be as high as .8, after allowing for test unreliability). With multifactorial inheritance, an exceptional father, transmitting only one of each of his 23 chromosome pairs to his son, will on the average transmit only half the genes which made him exceptional. The mother's contribution, if there is no tendency for like to marry like, will be centred on the average and so the son's ability will tend to be half way between that of his exceptional father and the average. The same regression to the mean applies from exceptional sons to their fathers. The effect of assortative mating (like marrying like) is to reduce the tendency to regress to the mean. For example, if men 72 inches tall married women equivalent to men of 70 inches, the sons would average 71 inches tall; only a quarter back to the average of the population instead of the half to be expected if the fathers had wives of average height. This would be the theoretical assumption if the effect of the genes was additive and there was no dominance or recessiveness between the alternative forms of gene. The effect of dominance is to increase the regression towards the mean. For example, if it were more common for two short parents to have a tall child than for two tall parents to have a short child, this suggests that some short individuals may be heterozygous for partially recessive genes for tallness which do not affect their own height much, but which may affect any of their children who are homozygous for such genes. The amount of the effect of the dominance depends on the relative frequency of the dominant and recessive alternative genes (Carter, 1962, p. 109). Thus, if the father only has a rare dominant gene and is exceptional because of it, he has a one half chance of passing it on to his son, so the effect of a rare dominant gene on the regression of son on father will tend to make it the usual half. On the other hand, if the dominant gene is very common, the exceptional fathers will be those who have the recessive gene for each member of this particular gene pair. Such a father will always transmit one such gene to his son, but the gene from the mother will nearly always be the much commoner dominant type. In that case there will be no resemblance between father and son and regression to the average of the population will be complete.

In practice most of the resemblances found between relatives for such traits as height and intelligence are close to those which would be given by simple multifactorial inheritance, without dominance and without assortative marriage. A comparison of children's intelligence with their father's occupation, suggests a regression of half (Carter, 1962, p.131). The IQ of 143 children of men in major professions (whose IQ would average around 135) was found to be 122 when tested in the 1947 Scottish survey. Since the average IQ of the boys taking the test was 104, this gives a regression to the mean of about .4. The average score of 400 offspring of Terman's sample of gifted children (average IQ 152) was

128, giving a regression towards 100 of a little less than one half. In 1940 Roberts found a regression of close to one half in a survey of all the ten year old children in Bath with their brothers and sisters of school age. These results were obtained in spite of the tendency for assortative marriage for qualities such as intelligence and the effects of similar environment. "This nice agreement with theory must" Carter considers "be due to the mutually balancing effects of modifying factors, genetic and environmental". While assortative marriage and common family background tend to increase the resemblance between relatives, dominance and damage to the brain before or at birth may lessen resemblance.

Besides 22 pairs of matching "autosomes", human females have two similar X chromosomes and males one X and one very small Y chromosome. The sex of a child is determined essentially by whether the father transmits his X or his Y chromosome.

Because the X chromosome is much larger than the Y chromosome, for many genes on the X there are no corresponding genes on the Y. This leads to special patterns of "sex-linked" inheritance, particularly with recessive genes. A woman with such a gene on one X chromosome only will not be affected by it, but a man with such a gene on his X chromosome will have no normal alternative gene on his Y chromosome and will be affected by it. The man will not transmit the trait to his sons, but his daughters will all be carriers, since they receive an X chromosome from their father. When they come to have children, half their sons will inherit the trait and half their daughters will be carriers.

If a gene were linked with the Y chromosome, all a man's male descendents would be affected, but none of the female line. No certain cases of Y-linked inheritance are yet known, though some will almost certainly be found (Carter, 1962).

In sex-limited inheritance, men only show the trait (e.g. a certain form of premature baldness). Women can inherit it from their fathers and transmit to their sons, but do not show it themselves, perhaps because the glandular makeup of the two sexes may govern the way in which the gene expresses itself. The distinction from sex-linkage is readily made by the fact that in sex-limitation men can transmit the condition to their sons.

CHAPTER VII

THE INHERITANCE OF MUSICAL ABILITY

Introduction

The first part of this chapter is concerned with the question how far musical ability depends on heredity or environment.

Most psychologists of music might nowadays agree with Farnsworth (1958, p.184) when he says "It is now clear that neither nature nor nurture can alone make a musician. Both must be present before musical and other abilities can emerge". Nevertheless, opinions differ as to which side should be stressed. Wing and Drake emphasise the importance of innate factors (see Wing, 1963; 1941a, p.350 and 1948, p.77; Drake 1957, p.13). On the other hand, Farnsworth himself and Lundin with his "interbehaviourist" theories (see 222 below), seem to lose no oportunity of pointing out the contribution of environmental factors. This may be partly because they have in mind the need to qualify the somewhat dogmatic statements of Seashore, Schoen and Kwalwasser on the hereditarian side. For example, according to Schoen (1940, pp.161-3) "Musical talent is first an inborn capacity. Artistic musical performance rests ultimately on innate, inborn equipment"; while Seashore (1919, p.6) stated, "Not only is the gift of music itself inborn, but it is inborn in specific types".

The evidence available on this question consists of

a) a few studies based on measuring and comparing the musical aptitude of twins and other relatives. Unfortunately the tests used were in most cases not the most valid or reliable;

b) data collected by questionnaires on overt signs of musical activities; and

c) studies of the families of well-known musicians.

In addition, data on the early appearance of musical ability and particularly of the exceptional talent of prodigies, and even on idio-savants have some relevance. A brief account of these will, therefore, be given before discussing how the various studies should be interpreted.

The second part of the chapter deals with attempts to relate the inheritance of musical capacity to Mendelian mechanisms.

Genetic Studies of Musical Ability using Tests

Kwalwasser (1955) summarised the results of 3 student researches based on the K-D tests. The correlation between the K-D scores of 255 pairs of siblings was .48 (Swift, 1939). The 71 pairs of brothers' scores produced a slightly higher correlation, .56, than did the 65 pairs of sisters. Williams (1952) obtained a correlation of .53 with 151 negro siblings. The K-D scores of 25 sets of twins gave a correlation of .77 (Mizer, 1941). Unfortunately, Kwalwasser did not mention how many of the twins were considered identical. Their scores on the Kwalwasser-Ruch Music Accomplishment Tests correlated even more highly (.84). Achievement tests have been found to correlate more closely than intelligence tests, especially among fraternal twins and siblings brought up together (Newman et al, 1937). These coefficients are, as Kwalwasser pointed out, similar to the results obtained from twins and siblings on intelligence tests, in spite of the questionable reliability of the K-D battery.

Kwalwasser also mentions three attempts to compare parents and children (Oakley, 1946; Scriber, 1946; Sontheim, 1946). However, all three found the mothers, though interested had difficulty in arranging time to be tested, and the fathers proved rather disinterested and unco-operative. The correlations were "lower" than those found among the siblings. (Kwalwasser does not state the exact coefficients). This may have been due, he suggests, to the unfavourable attitude of the parents, the considerable difference in age affecting the test results, or to a deterioration of hearing on the part of the parents.

Several tests of auditory and musical abilities were included by Vandenberg (1962) among the tests administered to the identical and like-sexed fraternal twins who took part in the Michigan Twin Study. The following table summarises his results with the Wing and Seashore tests. The significance of a ratio obtained by dividing the within-pair variance for the DZ by the within-pair variance for the MZ twins was evaluated by Fisher's F test. h^2 (see p. 183) was also calculated, using Clark's formula $\frac{\sigma^{2}_{DZ} - \sigma^{2}_{MZ}}{{}^{2}_{DZ}}$ (Clarke, 1956).

Table X

Test	h^2	F		N_{DZ}	N_{MZ}
Seashore Pitch	-	.95		33	43
Seashore Loudness	44	1.78		33	45
Seashore Rhythm	52	2.07	.05	33	45
Wing Pitch	12	1.14		34	44
Wing Memory	42	1.72	.05	34	43

An F ratio beyond the .05 level was reached with the scores of factors A and D of Cattell's IPAT Test of Musical Preference. It would seem very likely that twins would tend to influence each other's musical preference, though identical twins brought up apart have been known to develop similar tastes (see p. 370 below). Acuity of hearing proved highly heritable. This was truer of the right ear than of the left, perhaps because of the effects of an hereditary right-left preference (see Vandenberg, 1962, p.234). The audiogram at all four levels reached a probability of beyond .01 for the right ear, but .05 for the left ear in only one case.

Vandenberg's results suggest that the ' ing and Seashore tests used are, generally speaking, less under hereditary control than the Thurstone Primary Mental Abilities. The .01 probability level was reached for the number, verbal and word fluency parts and .05 for spatial part. Only reasoning and memory failed to show a significant hereditary component.) To some extent this may be due to the music tests, especially Seashore's Loudness and Rhythm tests being less reliable than Thurstone's. However, both the Seashore and the ing Pitch tests should have satisfactory reliability and it is surprising that the h^2 obtained should be so low.

Rife, on the contrary, apparently has "good evidence" (referred to by Fuller and Thompson, 1960) of MZ twin similarities on the Seashore pitch test. It would be interesting to know if the small difference in Vandenberg's result was due to the DZ twins being rather similar or to a number of the MZ pairs showing large intra-pair differences. Vandenberg does not state if any allowance was made for differences of age While most of the children were between 16 and 18 (i.e. were old enough for age not to be an important factor), the ages did range as low as 12 and might have had some differential effect on the results. If the short first Wing test could have been included, the total score for the first three tests would have been interpreted in accordance with Wing's norms. But at least the Wing Memory test and Seashore's hythm test do appear to have definite heriditary components on this evidence (the Loudness test must be very close to showing a significant difference). Vandenberg himself suggests that

"It may be that only the exceptional talent of great composers and usicians has an hereditary factor... It is also possible that limitations or defects are more properly the object of concern of hereditary studies rather than proficiencies". For the educational psychologist, however, the study of the hereditability of average and superior talent (below the level of genius) is at least as important as investigating musical defect.

One study of identical twins brought up apart included the results of testing their musical ability (Yates and Brash, 1941). JB apparently showed a definite aptitude for music. From the age of 9 he chose to study the violin and had lessons for 5 years. Though his progress was satisfactory lessons had then to be discontinued due to shortage of money when his father lost his job. JJ's only special talent was trumpet playing, which he took up at 14. He played in small amateur dance bands. In view of their interest in music, Vernon included the K-D battery among a number of psychological tests administered. "Over the whole series JB was much superior to JJ and this was not surprising in view of JB's superior musical education. However, there was no general rese blance between the patterns of their scores on the individual tests, such as would indicate a genetic basis to their musical talent".

Mjoen's extensive studies of the inheritance of musical ability included an investigation of the pitch discrimination of parents and children. He administered a pitch test to groups of parents and children and found a high correlation between the midparental score and that of the children, thus confirming Rife's result (see above). His sample was not representative, since the majority of parents were superior to the norms for a large sample (Fuller and Thompson, 1960). This homogeneity, however, might tend to depress, rather than raise, the correlation (see also p.301).

Smith (1914) found the pitch discrimination scores of siblings after practice correlated .48, those without practice correlated .43. However, when he compared the younger children with unrelated children of the same age and sex as their siblings, the correlation obtained was .53. Smith was unable to offer any satisfactory explanation of this finding. Near zero correlations are to be expected from a random sample of unrelated children. This was found to be true of the data of Swift and of Williams (Cf. p. 190 above).

Friend (1939) attempted to apply the Seashore tests of pitch, intensity and consonance as adapted by McGinnis (1928) individually to 20 boys and 22 girls whose mean chronological age was 5:3 and mental age 5:11. The tests were simplified by shortening the amount played and by increasing the interval between judgments. The children were given the tests twice within a week. The coefficients of reliability on retest were: pitch .57, intensity .61, consonance .51 and combined tests .778. However, correlations with the test scores and teacher's ratings of the children's musical ability was low (.15). All three teachers had good opportunities of knowing the children and their ratings agreed quite closely. The sum of the parents' ratings of their children's ability also showed a low correlation (.26) with the children's Seashore scores. The parents were tested with the three Seashore tests, applied once. The following correlations were obtained between the mean of the parents' scores and the child's mean for two trials: pitch .14, intensity .46, consonance -.11. The correlations with the 25 fathers were: pitch .02, intensity .16 and consonance .04, while the 35 mothers' scores correlated with the child's .09 for pitch, .28 for intensity and -.08 for consonance. The highest correlations were thus obtained for intensity, the most reliable of the single tests as used in Friend's study. This might be due to the children having a clearer conception of 'loud' and 'soft' than of 'high' and 'low'. Seashore himself (Hattwick and Williams, 1935) came to the conclusion that even children of between 6 and 9 had not adequate concepts of 'high' and 'low', even after practice and explanation, to undertake the Seashore pitch test. Friend herself doubted if the answers to the consonance test (a test no longer part of the Seashore measures) were based on any real aesthetic judgments. Negative correlations were obtained between the parent's estimate of the child's musical environment and the Seashore scores: with pitch -.24, intensity -.32 and consonance -.14, total of the three tests

tests -32, or - 10 if radio listening was omitted.

Given satisfactory tests of the musical aptitude of young children, the results obtained from such an investigation might prove of considerable interest.

Stanton (1922) tested the families of six well-known American musicians with the Seashore measures of pitch, intensity, time and tonal memory. The Seashore records were used for the last three tests and tuning forks for pitch. Eighty five persons were interviewed and tested. Their ages ranged from 8 to 80. A three generation study was possible in the case of five of the families.

Wing regretted that Stanton did not employ random cases (1948, p.80). However, she intended her investigation to be partly an exploration of how standardised tests could be applied in genetic study. Adults are more likely to be willing to undergo testing if they are musical or interested in music. In fact, a number of her subjects were unmusical. Fuller and Thompson (1960), commenting that the basis of her sampling was too narrow, thought that a larger scale investigation might yield material of genetic value. From the point of view of music psychology, it would be desirable to include valid tests of general musical ability in preference to measures of sensory capacities.

Some example of the rather low validity of the Seashore measures are to be found in her results. Thus in the family designated Kappa, IV 11 was superior score in pitch and higher average in memory, yet he was not able to carry a tune, while IV 9 was only lower average in pitch and memory but could carry a tune, though he did not play. A member of the Rho family was a piano and singing teacher. Her tonal memory score was very high, but her P.R. was only 60 for time and 35 for pitch. However, the four persons with the best Seashore profiles were all highly active musically. The four persons with the poorest talent profiles had had little music at home as children; only one had received music lessons - six years of piano lessons without achieving much success; and they had shown little desire to learn.

Stanton presented her results in the form of talent profiles for each family and in various tables. But she did not attempt to correlate parents and children's scores or those of siblings. She herself raised the question of how far the percentile ranks of her older and younger subjects were strictly comparable, and thought further research might show a need for a P.R. for subjects aged 45 to 65 and another for those over 65. Her graph plotting pitch scores against age shows a fall in the 40's, a recovery around 50 and a marked decline after 60. Tonal memory (the test most likely to be valid in the sense of relevant to musical progress) showed little effect of change with ageing. It would have been interesting to have had correlations at least for this test and for the total Seashore scores with age partialled out.

Table XI. Parents and Childrens Ranks in the Seashore Measures

S = Superior (P.R. 70-100) A = Average (L.R. 30-69)
P = Poor (1-29)

	Parents Talent	n.	Children S	A	P	Total
Pitch	SxS	8	15	1	0	16
	SxA	4	11	0	0	11
	AxA	1	1	0	0	1
Intensity	SxS	4	6	0	1	7
	SxA	3	5	1	0	6
	AxA	1	0	0	1	1
	SxP	4	5	4	2	11
	AxP	1	0	1	0	1
Time	SxS	3	5	0	0	5
	SxA	4	3	2	1	6
	AxA	1	2	1	1	4
	SxP	3	0	5	3	8
	AxP	2	3	0	0	3
Memory	SxS	4	4	1	0	5
	SxA	7	14	2	1	17
	PxP	1	0	1	0	1

Among the results reported by Stanton are tables for each of the Seashore sub-tests showing the P.R.s of the children produced by the mating of parents of various levels of talent. Her figures for the cases where both parents were tested are reproduced in table XI. Most of the parents are above average, but their children tend to be superior to the average of the parents. She concluded that it was "not improbable" that the inheritance of musical capacities followed Mendelian principles.

Stanton collected supplementary data on environmental factors. How superior were her subjects' musical backgrounds and experience can be judged from her three categories, e.g. Home Musical Environment during Youth Grade A: One or both parents professional musicians;

Grade C: Several members of family studied music. Daily playing or singing; and

Grade E: Self-practising. One parent played occasionally. No music at all.

Musical training: A: Major in music; extensive private study; 1 or more years study abroad;

C: Music courses taken and several years playing; and

E: 3 or 4 years of instrumental lessons early in life; no musical education at all.

B and D were kept in reserve for possible further subdivisions.

Table XII. Stanton's subjects' Seashore talent profiles compared with environmental factors

Childhood Musical Environment	Seashore Talent Profiles				
	Superior	Excellent	Average	Poor	Total
A	13	8	1	0	22
C	13	10	9	1	33
E	5	5	7	4	21
	31	23	17	5	76
Musical Training					
A	9	3	0	0	12
C	8	6	5	0	19
E	8	8	9	5	30
	25	17	14	5	61
General Education (after Graduation from high school)					
A	14	7	5	2	28
C	7	5	3	2	17
E	4	5	6	1	16
	25	17	14	7	61
Musical Activity					
A	8	5	0	0	13
C	8	1	3	0	12
E	9	11	12	5	37
	25	17	15	5	62

From the above table there appears to be some association between the environmental factors and the talent profiles, but it is nowhere striking. Stanton tended to interpret e.g. the higher proportion of individuals with superior talent who enjoyed good musical backgrounds as children in terms of their having inherited their aptitude from musical parents who provided musical environments. She noted the relatively high proportion of talented persons who had not received musical training.

Questionnaire Studies

In the studies summarised below, musical ability was assessed entirely or partly by questionnaires. Since questionnaires are generally less time-consuming both for the experimenter and the subjects than are tests, more subjects can be included in questionnaire surveys. However, the adults willing to take part are likely to come from the more literate sections of the population and to be more than averagely interested in music. When the questionnaires are applied during, or are followed by, a personal interview in which doubtful replies can be clarified and when the information is supplied by the person himself, rather than a relative, or where replies from different members of the same family can be compared, the results obtained are more likely to inspire confidence.

However carefully carried out, questionnaires do depend on the accuracy of the subjects' replies. Subjects might be expected to err in the direction of overestimating their own or their relatives' ability, but it would be difficult to estimate whether the unmusical, the average or the talented would be most prone to such error. In most cases the data refer to achievement, rather than capacity. They therefore do less than justice to individuals whose opportunities to develop their musical aptitude have been poor.

Heymans and Wiersma (cited Revesz, 1953) asked 423 "educated persons" to describe mental and emotional characteristics of both parents and all their children. Questions on "musical ear" rightly considered as a "particularly important index of musicality" were included. The following table summarises their results.

Table XIIIa

	%age of the children		
	Good ear	Bad ear	Indefinite
Both parents with good musical ear	84.0	10.4	5.6
One parent with good musical ear	59.4	35.9	4.7
Both parents without musical ear	29.7	62.5	7.8

Similar findings were reported by Haecker and Ziehen (1922) who asked 485 subjects several questions regarding their musical aptitude and activity such as "Do you play, or have you played, any instrument? Do you sing? Do you recognise musical compositions on hearing them again?". The subjects were graded into five classes: extremely musical, very musical, moderately musical, unmusical, absolutely unmusical. The following results were obtained:

Table XIIIb

	%age of the children Extremely musical	Moderately musical	Unmusical
Both parents extremely musical	85.6	6.5	7.9
Only one parent musical	58.6	15.0	26.4
Both parents unmusical	25.4	15.9	58.7

The close agreement between the results reported from these two different studies is indeed remarkable. That no less than 25% of the children of unmusical parents are described as being very musical might be partly due to the parents making more generous estimates of their offsprings' ability than of their own. Also, the ability may have been inherited from grandparents.

In order to give some degree of objectivity to the assessment of his subjects' musical ability, Mjoen (1926; 1934) used a musical index graded from 0 to 10. In the following table those described as (P) "Poor" were rated between 0 and 2. Their ability was limited to being able to recognise a piece of music (2). The (M) "Musical" (3-7) ranged from those who knew when they sang or played out of tune through grade 5, holding a second part to playing an instrument, to (grade 7) improvising a second part. The (S) "Superior" group (8-10) were, at the least, able to play by ear, while the most talented of all could compose and play several instruments.

Table XIV

Parents	Number of parents	Number of children	%age of children S	M	P
SxS	7	23	72	28	0
SxM	40	175	60	34	6
SxP	9	34	26	37	37
MxM	30	113	39	49	12
MxP	21	75	7	40	53
PxP	7	22	0	10	90
Total	114	442			

The higher the average talent of the parents, the higher the average talent of the children is likely to be (Mjoen, 1926). The environmentalist might object that the musical environment provided by the parents is likely to vary mughly with their own talent or lack of talent. Mjoen, however, also presents evidence that where both parents are musical (grade 5 or above) the proportion of children who are musical corresponds to the number of grandparents with talent. Thus where three of the grandparents are musical, 90% of the children are likely to have musical aptitude, if only one grandparent has talent, only 50% of the children may be musical. Mjoen, therefore, concludes that it is the quality of the stock rather than the quality of the parents which determines the ability of the children. He quotes the following case as an illustration. The four children of a grade 4 parent married to a grade 5 were rated as grade 5. One married a woman with little musical aptitude (grade 2); their children averaged grade 3 in musical ability. One daughter's spouse was very unmusical; one of their children was rated grade 2 and a second grade 4. On the other hand, a daughter who married a mah with grade 6 talent and siblings whose ability averaged 7 produced seven children whose capacities ranged from 5 to 10. Her sister also married a man whose aptitude was rated as 6. However, his siblings were less musical (average 3). The ratings of their three children were only 3, 4 and 5.

Among the family trees studied by Mjoen was that of the Norwegian composer, Halfdan Cleve. His father who was very musical and came from a musical family married twice. His first wife was unmusical and came from unmusical stock. None of their five children showed musical aptitude. His second wife, however, was musical. All their five children were above average musically, and one, Halfdan Cleve himself, very gifted. Halfdan Cleve married a well-known pianist, who came from a musical family, one of her siblings being highly talented. The four children resulting from their marriage showed promise of exceptional talent.

Another family mentioned by Mjoen was that of an international concert player. Her husband was musical and came from a musical family. All seven of their children, as might be expected, were highly talented. However, her own family was evidently quite without talent. Happily for Mjoen's theories, he discovered that she had been adopted and that her natural father was an eminent musician.

Mjoen (1934) also studied the effects of different degrees of assortative mating on the ability of the 442 children to which table XIV refers. When there was only a slight divergence between the parents' ratings the talent of the children averaged a little higher than the average of the parents. As the divergence increased, the average talent in the children declined. When the maximum divergence between the parents (8-9 points) was reached, the average of the children was 1.80 lower than their parents' average.

Stanton (1922) included in the report of her investigation (see p. 197 above) the ratios of musical and unmusical children produced by various combinations of parents. The stock from which the parents came was taken into consideration. Since she included members of the family whom she was unable to test, her criteria of musicality for all the subjects was their participation in musical activities and the interest they showed in music. The following table summarises her results:

Table XV

	n. of matings	Children (at maturity) Musical n.	%age	Unmusical n.	%age
Both parents musical and from musical stock	5	10	91	1?*	9?
One parent musical and from musical stock, the other unmusical and from unmusical stock	10	6	37.5	10	62.5
Both parents unmusical and from unmusical stock	6	-	-	25	100

*The normal growth of this individual was stated to have been "inhibited"

According to the above table the likelihood of unmusical parents producing musical children is considerably less than suggested by Heymans and Wiersma, and by Haecker and Ziehen. This might be due to Stanton's smaller number of subjects, who did not include any children of unmusical parents of musical stock nor musical parents from unmusical stock.

Wing (1948, pp.78-81) graded 333 boys aged 14-18 years into AB (above average), C (average) and DE (below average) according to their performance in his tests. Taking whether or not their parents played as the only available criterion of parental ability, Wing found that the proportion of unmusical (non-playing) parents to musical parents was about 10:1 for the below-average group and 4:1 for the above-average group. Moreover, if both parents played the child's chance of having higher than average ability was much greater than if neither or only one parent played. He concluded that these figures could be satisfactorily interpreted as evidence of the inheritance of musical capacity (see further p. 263).

Drexler (1938) compared her 23 subjects' ability to learn to sing two melodies (cf. p. 150 above) with their parents' judgment of their own ability to carry a tune and the length of time (if any) they had studied singing. The correlation between mother and child was .62, that between father and child .37. The higher correlation with the mothers was not unexpected for such an activity as learning a song, since the children would have spent much more time with their mothers than with their fathers, and probably found a man's voice harder to imitate.

Studies of the Families of Musicians

Many of the musicians sufficiently eminent to be listed in Grove's "Dictionary of Music and Musicians" appear to have been born into families where some degree of musical talent was already present. Revesz (1953, p.192) listed 36 well-known musicians whose fathers had been talented and 4 whose mothers were musical. Kwalwasser (1955) gives many examples of talent in parent and child and among siblings.

Galton (1896) had difficulty in obtaining a list of first-class musicians that would command general approval. Out of 120 whose families he studied, 26 (about 1 in 5) had eminent kinsmen, not all of whom were musicians. Feis (1910) made an extensive genealogical study of the parents and children of 285 famous musicians, but found the data on the maternal lines very hard to obtain, so that the material he could assemble was seriously incomplete.

Scheinfeld (1956) collected the following data about outstanding performers, and from students of the Juilliard Graduate School of Music:

Table XVI

	Number	%age of relatives with some degree of talent Fathers	Mothers	sibs.
Pianists, violinists, conductors	37	75	50	50
Opera singers	36	66		40
Students of music	50	58	74	70

An analysis of the incidence of talent in the three groups of musicians and singers showed:

Where both parents had musical talent, more than 70% of the brothers and sisters (in addition to the individual reporting) also had talent.

Where only one parent was talented, there was talent in 60% of the siblings.

Where neither parent was talented, only 15% of the brothers and sisters had talent.

Among the virtuosi instrumentalists, the majority had talented parents - one or both. Yet quite a number reported no talent in either parent. Nor did the differences in the family backgrounds, or in there being both parents, one parent, or neither parent talented, seem to have anything to do with the calibre or quality of musicianship shown by the individual.

Giordano and Guli (1960) studied 200 members of six musical families, those of Bach, Beethoven, Mozart-Weber, Puccini, Sabata and Savagnone Abbado. In all, 96 members of these families were found to be musical, 4 having outstanding talent, 37 having some talent and 55 having "musical aptitude".

Of all musical families, the Bach family is the most notable. In six generations, taking into account only men (because of the limited opportunities for women) and omitting all not old enough to have demonstrated their capacities, the Bach pedigree included, besides Johann Sebastian himself, 29 professional musicians, 16 others who were composers, 2 known to have musical ability but who were not professional, and 7 who are not known to have had any special musical gifts (Shull, 1948, p.224). Mjoen (1926) mentioned Johann Sebastian as an example of a great man whose genius did not die with him through marrying an ungifted wife. His first wife was a cousin who presumably shared the Bach musical genes, their sons, Carl Philip Emanuel and Wilhelm Friedemann were both highly gifted,though less outstanding than their father. Bach's second wife was a musician. Their children included

Johann Christoph Friedrich, "a thorough musician" and Johann Christian who also had remarkable talent. Kalmus (1949) suggested that the intrusion of a tone deafness gene (see p.233 below) into the Bach family might partly explain the disappearance of talent from later generations.

To sum up, certain families appear to have more than their "fair share" of musical capacity, compared with the population in general. How far this may be due to home environment or to family inheritance will be discussed in a later section (p. 222 below).

The Early Emergence of Musical Talent

The mere fact that musical aptitude can emerge early in life when the child has lived for only a comparatively short period in his post-natal environment may seem to argue for its innateness. This may be especially true of the outstanding degrees of talent shown by musical prodigies.

From data collected by Haecker and Ziehen from 441 cases, Revesz (1953) concluded that nearly 50% of the children revealed musical aptitude between their second and sixth years. From parents' reports on the age at which various superior abilities were first noted in his sample of gifted children, Terman (1925) found that, except for general intelligence, musical ability was shown at the lowest age. The average for boys (n. = 91) was 4.6 years, for girls (n. = 108) 5.16 years. The reliability of parents' reports may be thought to vary considerably, but at least the public performances of musical prodigies provide reliable evidence of precocity.

The history of music provides many examples of conspicuous musical talent being displayed by young children, not only as performers but also as composers. In the course of her descriptions of the early lives of 11 eminent composers, Cox (1926) mentions many instances of their precocity. Among the instrumentalists studied by Scheinfeld (see above) musical talent appeared at an average age of 4¾ and in the case of the Juilliard music students at 5½. In the case of the opera singers, formal training did not begin till the age of 15½ for women and 16½ for men, though in both cases musical talent was said to have been shown about seven years earlier. The average age of their professional debut (not merely their first public appearance) was 13¼ in the case of the virtuosi.

Revesz (1925) mentioned the ages at which some of the famous composers produced their first known compositions. He commented that children with creative as well as interpretive ability usually appear before the public as executants much earlier than as composers. Thus Handel was well-known as an organist at eight, but his first compositions date from his eleventh year (or perhaps later). Bach was 18 before he wrote his first organ works, though he probably extemporised at an earlier age. Beethoven's first compositions are said to date from his twelfth and thirteenth years. When Brahms was between ten and twelve, his piano teacher complained of his habit of composing. Mendelssohn's creative gifts developed rapidly and prolifically after the age of 10. Before he was 12, he had composed an opera. Schubert is said to have written a number of songs and piano pieces before his tenth year. Chopin is reported to have composed for the piano at 8. The creative activity both of Saint-Saens and of Haydn is reported to have begun at 5. Mozart's earliest extant compositions, three Minuets, an Allegro and a Minuet and Trio, date from 1762, when he was six.

Mozart was one of the greatest (if not the greatest) musical prodigies of all. His talent was discovered because of the keen interest he took at the age of three in his sister's music lessons. He would amuse himself for hours picking out thirds and showed a good memory for tunes that he had heard. His father, himself a talented musician, soon started giving Wolfgang lessons and writing down the little pieces which his son composed. In 1762 he took the children on their first tour. By the age of seven Mozart was giving public recitals in London. Though Revesz (1953) stated that to what extent Leopold Mozart was a collaborator in his son's first compositions cannot now be determined, the father seems to have been genuinely surprised at the boy's spontaneous displays of talent (Holmes, 1845).

Pointing out that it is difficult to assess the amount of training Mozart received and the effect of his musical environment, Richet (1900) reported the case of Pepito Areola whose talent appeared before he had had any training whatsoever. Pepito's father was not musical but his mother had played the piano at the age of 5, while his maternal grandmother is reported to have been a good guitar player. When hardly 2½, Pepito played tunes on the piano. Sometimes they were tunes his mother had played or sung, sometimes they were of his own invention. When investigated at the age of 3:7 by Richet he could play twenty pieces from memory, including the harmonies. He used clever fingering to make up for the smallness of his hands. His improvisations showed some feeling for form. He appears to have been rather temperamental and refused to be corrected. For a time the only instrument on which he could be induced to perform was his mother's piano.

The most detailed investigation of a musical prodigy is that of Revesz (1925) who was able to observe Erwin Nyiregyhazi from his sixth to his twelfth year. Erwin's father and paternal grandfather were singers in the chorus of the Royal Opera in Budapest. His mother also possessed considerable musical talent. His younger brother, who was five years old at the time Revesz wrote his book, was "remarkable for a strong feeling of rhythm and a very good musical memory". According to his father, Erwin tried to imitate singing before he was one year old. In his second year of life he would reproduce correctly melodies sung to him. At the beginning of his fourth year he began to play on the piano everything that he heard. He also improvised. In fact, at 3:6 he had already composed little melodies. From his fifth year he received some piano lessons, but regular tuition in music began only when he entered the Academy of Music at 6. When tested by Revesz, his musical ear, at 7, was already extraordinarily developed. He could analyse complicated chords with great accuracy. His immediate musical memory was nearly as good as that of an adult pianist whose musical memory was known to be very good and his power of retention for a half-an-hour or a day were much better. He could memorise melodies harmonised in a simple manner with the greatest ease. He had no difficulty in retaining a great number of operatic airs in his memory but usually could reproduce without mistake only the melodies without the harmonies. He reproduced faultlessly at the third attempt a thirteen-note tune played to him by Revesz. Two years later he was able to reproduce without mistake a five-bar theme at the second attempt, the time taken for learning being 22 seconds.

Erwin later emigrated to America and became a professional musician though without achieving the renown which might reasonably have been forecast for him (Farnsworth, 1958, p.185).

Not all prodigies fulfil the promise of their early youth. Speaking from the experience of having taught over 3,000 pupils,Cortot (1935) stated that the proficiency which some children display is no more than the manifestation of dexterity and an extraordinary natural imitative faculty. However, very many infant prodigies, like Yehudi Menuhin and Lorin Maazel, do become highly esteemed adult musicians. 70% of the great violinists listed in Leahy's "Famous Violinists" were prodigies (Drake, 1957, p.13).

Certain individuals have adopted careers outside music and later earned renown as composers. Borodin was a professor of chemistry and Moussorgsky and Cui had military careers. All three, however, had shown aptitude for music early in life. Borodin was able at 8 to reproduce on the piano music he had heard. He was taught to play the flute and the piano. Moussorgsky's mother gave him his first piano lessons. At 7 he could play small pieces by Liszt and before 9 Field's concerto. Cui showed a precocious talent for music and was taught the piano at an early age (Grove's Dictionary, 1954).

This does not mean that musical ability must necessarily be shown at such early ages. For example, Malcolm Tillis had sufficient talent to become a viola player with the Halle Orchestra. His family was not particularly musical. At 11 he was taken to see "Carmen" and fell under the spell of music. After that he took every opportunity of listening to music on the radio, but did not begin to learn an instrument till he was 15 (Tillis, 1960).

No doubt, as Wing (1954, p.168) pointed out, the talents of the genius would be easier to evaluate if the conditions of normal growth of musical ability were better understood.

But the high degrees of talent displayed is in many cases quite out of proportion to the amount of environmental stimuli.

Idio-Savants

The existence of individuals of very low intelligence who yet show somewhat better than average musical aptitude are sometimes mentioned in the literature as evidence that musical ability is relatively independent of general ability (Drake 1940; Farnsworth 1958). But the extent to which their ability can be regarded as inherited has also been the subject of some discussion.

A well-known case was that of Blind Tom, who became a vaudeville artist. He was evidently able to memorise a piece from one learning, and to play two tunes and sing a third at the same time. Afterwards he would join the audience in applauding himself. His manager may, of course, have encouraged such signs of "idiocy" for publicity reasons.

Tredgold (1922) mentioned a woman at the Saltpetriere Institution. Though an imbecile, a cripple and blind from birth, she could sing any selection of tunes which she had heard. Her fellow inmates came to her to have their mistakes in singing corrected.

Rife and Snyder (1931) described a blind imbecile girl who could play a new and difficult piece on the piano after hearing it only once. A musician visiting the Vineland

Institution where she lived asked her to play an unpublished composition of his. This she was able to do perfectly after hearing it only twice.

Though, according to Tredgold, the special talent shown by idio-savants has rarely been marked in their ancestors, Rife and Snyder decided to study as many of the relatives as possible of such cases as they could locate. Their aim was to demonstrate "the importance of the genetic make-up in the development of mental qualities". By addressing an enquiry to 55 American institutions for the feeble-minded, they succeeded in finding 33 idio-savants, of whom 8 showed a special talent for music.

They studied personally a case earlier reported by Minogue (1923). XY had developed normally till 3 and had learned little songs. After contracting spinal meningitis he was left mentally impaired. At 14 when he entered Letchworth Village his IQ was 62, at 23 (when Minogue described his case) it had fallen to 46. He could play jazz or classical music by sight or by ear. His memory for time, place and music was "almost phenomenal". During his childhood he had received 2 years piano instruction, but had been abusive to his teacher. He was reported to be emotionally unstable, but played well when willing to attend. He produced no original compositions and could not learn to dance. His paternal grandmother was an exceptionally fine pianist, as was his cousin. His sister played the violin, but had apparently no unusual talent. His father was said to be moderately musical. His mother's family were above average in intelligence, but did not seem to be musical.

Rife and Snyder also mention an idiot aged 35 who could play on the piano any tune sung to him. The chords he used were correct from the point of view of harmony, though he had never received any training in music. Some of his normal brothers played or sang. Another idiot, aged 19, could play by ear anything he heard. He had a feeble-minded brother with no musical ability and a normal, though blind, sister who played the piano and composed.

Owens and Grimm (1941) reported the case of a woman aged 23½ with an IQ of about 20. She played the piano in the ward of the Institution that she had entered at 14. She played by ear popular music heard on the radio, also hymns. Her musical response seemed to need an auditory stimulus she could copy. Thus she had little ability to play tunes named, but played Brahm's Lullaby in the key in which it was hummed to her. Her home had acquired a piano when she was 5 or 6, but she had received no lessons. Two of her four sisters played the piano by ear, though none of her relatives was known to have any exceptional musical talent.

A more detailed study of an "idio-savant" with musical talent was reported by Scheerer, Rothmann and Goldstein (1945). This boy, whose IQ was 50 when tested with the Stanford-Binet battery, had shown from his third year signs of a remarkable interest and ability in music. He could at 3 recognise a melody if only part were played to him. He played only by ear though, in spite of his low IQ, he had learned to read a simple score. But there were surprising gaps in his performance and he was extremely wayward. His mother was a former school teacher, not particularly musical, but both his parental grandparents were musical. Scheerer, Rothman and Goldstein attributed his talent to "an initial endowment in the acoustical and audio-musical sphere, probably supported by kindred imagery, tonal memory etc." but which did not operate normally.

Tredgold (1922) considered that the ability of idio-savants "is the result either of some primary anomaly or of some fortuitous circumstance of early life which has aroused the child's interest and thence led to the concentration of all his mental activities upon one object ... the talent ... certainly owes much of its development to constant exercise". His son, R.F. Tredgold (Tredgold and Soddy, 1956, p.448) thought that it now "seemed more likely the condition is more of emotional origin, in which intellectual development has become ... obsessionally canalised". While this may be partly true, some initial endowment of aural capacities would also have been necessary before the concentration of interest could result in actual music making.

It would be interesting to investigate the ability of the relatives of idio-savants by testing.

Discussion of Hereditary Studies

The data summarised above might be interpreted as supporting the view that musical aptitude is largely innate because a) it tends to run in families, b) it tends to appear early in life and in individually varying degrees which do not seem to be related to the amount or quality of environmental stimuli.

On the other hand, Wallace (1914) contended that musical families like the Bach's and Couperin's were merely remarkable instances of the continuity of vocation. Since the child of a professional instrumentalist cannot be brought up in a sound-proof room, he hears music from his cradle and later may benefit from tuition from his parent and an easier entree into the music profession. The child of the composer, painter or poet is less likely to follow in his father's footsteps because the latter works in silence. Lundin (1953), too, considers that studies of family histories can support a view preferring the acquisition of musical behaviour just as well as they can support the inheritance theory. He points to the musical surroundings in which Bach and Mozart grew up and quotes Pronko and Bowles (1951): "both on his mother's and his father's side for two generations back there was not a single musician in Haydn's ancestry... The argument that the musical ability of the Bachs was hereditary because it 'ran in the family' should hold just as consistently for their

German-speaking activity* ... Their (Haydn's and Bach's) genius behaviour was the culmination of a series of events ... involving long hours of practice and other labor".

Vernon (1931, p.239) however doubted the effectiveness of a mere repetition of stimuli. Again, although many composers had good opportunities for the development of their musical powers and were encouraged and well trained in youth, others were either forbidden by their parents to take up music professionally or had little opportunity to do so. Though most composers had to struggle extremely hard before they were able to express themselves effectively, yet, from the consideration of Mozart, Schubert and Berlioz, it appears that the technical as well as the emotional aspects of the creative faculty can, in some way, be partly inborn. Scheinfeld, too, found that some of the greatest virtuosi that he investigated came from "the humblest and least musical homes; ... some of the lesser ones from highly musical backgrounds, with both parents professional musicians". Such a lack of consistent correlation between musical achievement and background would suggest strongly, Scheinfeld concluded that musical talent does not arise from any unusual <u>home environment, per se</u>. That a highly musical environment also (or alone) cannot produce talent was shown by the children of the virtuosi, most of whom showed no unusual talent.

It is not quite true that "for two generations back

*A more accurate analogy would be between speaking German and writing contrapuntal music.

there was not a single musician in Haydn's ancestry". His father had learned to play a harp and, although he could not read music, he delighted in singing alone or with Haydn's mother. Also, Michael Haydn, Joseph's brother, was a church musician of distinction and a third member of their generation had some talent as a singer. Haydn had no children - or none that can be proved his - who might have shown talent.

The forebears of certain musicians who apparently came from unmusical families may have lacked the opportunities to learn music. Had Gluck not been sent to school at the age of 12 his talent might never have developed. The first twelve years of his life were spent in a completely unmusical background, but as soon as he had the opportunity his ability showed itself very quickly. Whether some of his ancestors would have displayed talent given the opportunity is not known. It would appear to be somewhat more convincing to attribute Gluck's ability to an untraceable hereditary factor than to an environment known to be unstimulating musically.

Mjoen (1926) acknowledged a category of individuals whose talent could not be explained by the ability displayed by their parents or collateral relatives. To explain the biological appearance of eminent ability, Mjoen considered it was not sufficient to work with average values and quantitative investigations, because the nature of a quality might change under the influence of other qualities. Genius might be explicable in terms of combinations of congenital talents.

A possible genetic mechanism by which Scheinfeld supposed "special talents" might be transmitted is described below (p. 233).

Lundin (1953, p.175) states that he has "no objection to the concept of inheritance, per se, providing we try to discover what it is that we inherit", and further (p.190) that what he is arguing against is "the inheritance of mental powers for musical reception and performance". In his view musical "capacity includes, among other things, a sound nervous system, two hands, normal hearing structures, and other structures necessary for musical behaviour" (p.176).

The writer would prefer to formulate some tentative answer to the question "What is inherited?" in rather different terms. One answer might be "such genes (or more likely combination of genes) which predispose the individual to perceive, remember and judge music more (or less) efficiently than others not so endowed". In Chapter II the importance of the higher mental processes in musical perception was emphasised. However, it seems possible that the "higher mental processes" complex though they are, might be ultimately explicable in neurological and biochemical terms. (The philosophical issues raised here are outside the scope of the present thesis). If Lundin's 'sound nervous system' is meant to extend to the higher brain centres involved in musical perception and judgment, it might be tentatively accepted as adequate on this account. From the point of view of the present investigation, it seems more important to question how adequately Lundin's definition deals with the wide range of individual differences which are evident from the norms of music ability tests and other studies of the musical activities of young children (see Chapter IV). Does Lundin mean <u>any</u> child with a sound nervous system and normal hearing structures can develop a high degree of musical capacity if brought up in a musical background? Lundin agrees that deficient structures will obviously be limiting factors for musical behaviour and that the man born deaf is deprived of part of his biological equipment with which he may acquire musical responses. It is not clear whether, for example, tone deafness would be considered due to a "structural deficiency". Lundin does recognise that "all people with similar training do not achieve the same degree of proficiency in musical tasks" and that "these limitations are a function of both biological capacity and previous musical experiences". Lundin thus seems to have moved away from the extreme behaviourism of Watson (1930). He is willing to consider that the rate of maturation, admitted to be a function of heredity, is important. It is easy to agree with Lundin that musically precocious children often have a head start because of early development, so long as he does not mean to imply that the average child could "catch up". The more outstanding at least of the musical prodigies continue to develop far beyond the heights of achievement attainable by the ordinary person even with considerable training. Mere rate of maturation does not provide an adequate explanation of their exceptional degree of talent.

The Soviet psychologist, Leontiev, took the view that individual differences in special abilities like the power to reproduce sounds of a given pitch correctly only seem to be inherited. This is because "the reflex systems of which they are a function are formed only under certain definite condition they do not, therefore, always develop and, in the case of different individuals, they may have a different structure". The work of Leontiev and others on the tone deaf will be discussed in detail in the next chapter. But he does not seem to provide a real explanation of why some children fail to form the "links" and connections essential to the building up of the mechanisms involved in e.g. the correct vocalisation of musical sounds. If these depended mainly on the environment, it would be reasonable to expect a clear relationship between the individual's ability and the amount and quality of his musical experience. Admittedly, the environment even for siblings is never identical. However, the available evidence on within-family differences, and on differences between individual families and the population in general, seems definitely to support Wing's view that innate factors have over-riding importance.

<u>Attempts to Relate the Inheritance of Musical Ability to Biological Mechanisms</u>

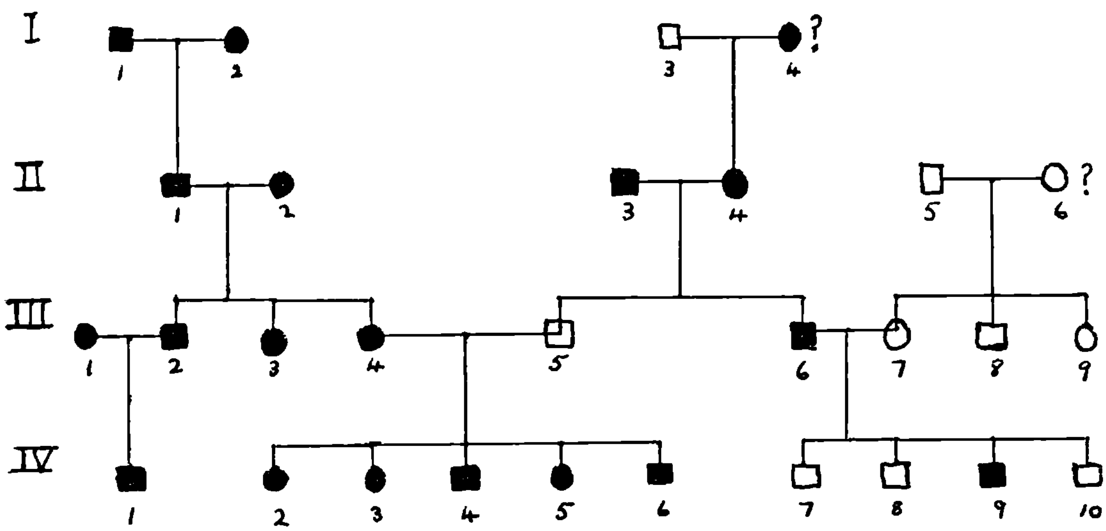
Hurst (1912) concluded from his observations of parents and children living in a Leicestershire industrial village that musical ability was a recessive trait. His criterion of ability - obviously a very rough one - was musical activity: singing, humming or playing. According to Hurst, when both parents are musical, all the children are musical; when neither parent is musical, signs of aptitude will be shown by none or only a few of the children. When only one parent is musical, either some of the children has ability, or 50% are musical or 50% unmusical.

Drinkwater (1916) tried to apply Hurst's theory to the pedigree of a family that had produced several distinguished organists. When both parents were musical, all the children - no less than ten in one case - were found to be talented. When one parent was unmusical but of musical stock, one half of the children were musical. But, in the case of this family and of others mentioned by Drinkwater, when only one parent was unmusical, the proportion of children showing talent often exceeded expectation. Drinkwater supposed that the mothers (the parents classified as unmusical) might in fact have had some ability, but that it had been eclipsed by their husbands' high degree of professional talent. The lack of a graded method of assessing musical ability leaves such questions unanswered. But the children of professional musicians, would have excellent opportunities of learning and some with only moderate gifts might have become competent musicians.

Rèser (1935) endeavoured to follow musical ability through five generations of one family. Unfortunately her main criterion of musical ability seemed to be the possession of a fine singing voice. It may have been the voice and not the ability to use the voice which was being handed down. For the first two generations of the family she was dependent on descriptions by living members of generations III to V. These may not have been accurate. The musical trait appeared to be passed on through the generations without a break; it was thus apparently inherited as a Mendelian dominant trait, but the progeny of the non-musical members of the family were not given and data about them would have been equally valuable.

Northrup ~~North~~ (1931) studied three generations of one family. In the first the father was highly talented and the mother unmusical. The second generation consisted of 5 musical children and one who was "musically inclined". A musical son married an unmusical woman and produced three definitely musical children and one moderately musical one. The other musical son married a fairly musical woman; their child was musical. A musical daughter married a man without talent; their four daughters showed ability but their two sons did not.

Ashman (1952) attempted to trace the biological mechanism of ability to carry a tune, through four generations involving members of three families. Though Ashman quotes Seashore scores for III 6 (P.R. = 51), III 5 (P.R. = 15 to 20) and for III 3 (P.R. = 76) (see pedigree chart below) most of his information appears to be based on his knowledge of the families. His report includes some comments on the individuals concerned.



Squares represent males, circles females. Blanks represent no ability in music.

The brothers, 5 and 6 from generation III, lived between the ages of 8 and 10 in the mountains of Virginia. They had no schooling and no musical contacts. As soon as they were sent to school, 6 rapidly learned to reproduce simple melodies from memory, while 5 never learned*.

In generation IV, male 7 enjoyed school music and gramophone recitals. He went to a college where behaviourist ideas prevailed and where musical ability was regarded "as an outstanding example" of an acquired ability. 7 practised hard, but without success.

IV, 10 was encouraged by his mother, though she was apparently not herself musical, to take lessons. Though he made rapid technical progress, he had no ear for music and no musical memory. His brother, IV, 9 received no encouragement to learn and no musical training, yet he could recall simple melodies*.

Ashman put forward the following biological explanation of the pedigree:

Individuals known to have had superior musical ability e.g. II 1 and 2 and III 3 and 4 are homozygous for an incompletely dominant gene.

Those in whom musical memory is apparently either absent or very deficient are probably homozygous recessives.

Musical memory, he concluded, is possibly determined by a multiple factor gene having other effects which are of survival value. A study of melodic memory might demonstrate differences among populations of value to the anthropologist.

If a distinctive condition can be isolated and characterised as present or not present, tracing the genetic

*These are further examples of sibling differences in an apparently similar environment.

mechanisms involved may become somewhat easier. Tone deafness seemed to be such a condition. Therefore, a joint investigatio of tone deafness was carried out by the Eugenics Department and Phonetics Department of University College, London.. A test was developed which appeared to discriminate efficiently between the tone deaf and the normal, at least among intelligent adults and adolescents. This distorted tune test consisted of the first two or more phrases of 25 well-known tunes. In one version the tune was played correctly and in a second the melody was distorted by the insertion of several blatantly wrong notes, the rhythm and tempo remaining unchanged. The subjects were asked to decide whether the tunes were played rightly or wrongly. Seashore's memory test, a number memory test and a pitch discrimination test were also used. Musical subjects occasionally marked a right tune as wrong (A type of error) because of some slight distortion in the recording or irregularity in the playing. Consistent marking of wrong tunes as right seemed indicative of some abnormality in the subject. This B type of error was given three times the weight of A and the scores were calculated as 3B-A (where B is the number of wrong tunes judged right and A the number of right marked wrong). A definitely bi-modal distribution was thus obtained. 95% of some 1200 subjects with marks of less than 14 were considered normal and the other 5% tone deaf (Fry, 1948). Performance of the Seashore memory test was invariably bad among the tone-deaf. A significant but weaker correlation with pitch discrimination was found. No very strong degree of association was found with the Number Memory test. That the results of the distorted tune test were not unduly influenced by opportunity to learn the specific songs chosen was indicated by the fact that Continental students who did not know them made hardly more type B errors than the English.

The tone deafness (or tune deafness as Kalmus called it) appeared frequently to segregate in families and siblings in such a way as to indicate that much of the variation might be due to a single gene, possibly a dominant (Kalmus, 1948). However, Kalmus (1952) stated "We do not know for certain whether tune deafness is caused by a single gene difference or controlled by many genetic factorx". He thought that there might be several types and that it was by no means independent of upbringing.

Scheinfeld (1956) put forward a theory on the inheritance of conspicuous talent. He agreed with Seashore that musical aptitude has specific components such as the sense of pitch, of rhythm etc. and that these have a constitutional basis. But while a foundation of such aptitudes is required before any talent can develop, something more is needed for real talent and virtuosity. Scheinfeld, therefore, supposed that the highly talented must have in addition "certain rarer 'special' genes which act either to intensify the effects of the more ordinary 'aptitude' genes or to produce some unusual supplementary effects".

In each of the three groups studied the incidence of talent followed the pattern quoted on p. 210 above. It is clear, stated Scheinfeld, that no single dominant gene, or no two recessive genes, could account for these ratios. A multiple-gene mechanism would be needed, and the simplest one which might fit the requirements would be, at the very least, two different dominant genes, passed on by only a single parent to a given child, or each parent could give the child one of the required genes.

Scheinfeld then applied this theory to Toscanini's family. The lack of talent reported in Toscanini's ancestry could be due to the paternal side of the family handing down only one of the required special "talent" genes, while on the maternal side the other had been carried - neither being effective by itself. Both genes were brought together through the mating of Toscanini's parents, when the chance of the combination appearing in one of their children was one in four or less. To explain why so little of Toscanini's talent has been passed on to his children or grandchildren, Scheinfeld pointed out that even if his wife (described as "mildly musical") carried one or both of the required "talent" genes, the odds might still be only about fifty-fifty of any given child receiving the required double combination. In fact, only one of Toscanini's three children appeared to have any talent at all and only the child of this daughter, out of the three

Toscanini grandchildren, showed any talent for music.

Giordano and Guli (see p. 211) considered that their own data suggested that musical aptitude was transmitted as an autosomic dominant trait, but thought it unwise to generalise. On the other hand - especially in cases where the genius suddenly emerges in a lineage - some "recessive biological tendency" (Vernon, 1931, p.240) might be at work.

Koch and Mjoen (1931) came to the conclusion that the inheritance of common musical talents seemed not to be dependent upon sex. However, Haecker and Ziehen's data seem to suggest that musicality may be inherited to a greater degree from the father than from the mother. 22% of the 74 cases of musically productive individuals seemed to have inherited their ability from both parents. In 25% of the cases the talent appeared to have been transmitted by the father alone, and in only 12% by the mother alone. (Haecker and Ziehen, 1922, cited Revesz, 1953, p.191). As mentioned on p.202, it is difficult to assess the effect which experience of music may have had on their results. It is possible that the child's opportunity of learning to play may have depended on whether or not his father was musical to a greater extent for these Continental families of 40 years ago than it would nowadays. Swift also found that the K-D scores of brothers were more closely associated than those of sisters (see p.190). Since some of the K-D tests can be affected by training, if the girls had received more instruction than the boys, this might have tended to increase the differences between them. Similarly in Drinkwater's and in Northrup's pedigree charts (see p. 228) when parents have unequal talent, the children often tend to resemble the father rather than the mother. But it is hard to assess how far this might have some genetic basis.

As in the case of general intelligence (see Carter, 1962, p.163), it is probable that numerous genetic factors are concerned in the inheritance of musical ability and that these will not be easy to unravel.

Conclusions

The writer would agree with Wing's assessment of earlier hereditary studies: the methods used cannot be regarded as entirely satisfactory, but nevertheless the general opinion put forward favours the view that musical ability is inherited. (See Wing, 1941a, p.358; 1948, p.80).

The evidence on how far pitch discrimination is under hereditary control appears to be contradictory. (See pp.193-5). It is not unexpected that Seashore's pitch test should differ from his rhythm test in amount of its innate element. But it is rather surprising that Wing's pitch test should apparently depend appreciably less on inherited capacity than the Wing memory test, since the intercorrelation of the two tests is high (Wing, 1941a, p.243).

While most of the authors whose hereditary studies have been mentioned above agreed in believing their data provided evidence that musical talent was inherited, there seems to be less agreement on the genetic mechanisms involved.

CHAPTER VIII

THE EFFECTS OF TRAINING AND OF INCIDENTAL LEARNING ON MUSICAL ABILITY

Introduction

The effect of instrument training on performance of various tests of musical ability was discussed in Chapter I in as so far as it might affect the prognostic value of the tests.

The present chapter is concerned with how far musical aptitude can be improved by a) practice and specific coaching with test material, singing etc., b) instrumental lessons and c) the "incidental" stimulation of listening to music over long periods of time.

Many factors may be involved in how far any kind of training affects the individual e.g.:

Age. Chronological, Educational, Mental, Musical and, in the case of playing, the motor development of the child. If the lessons are begun too early or the child is rather low in intelligence, the first year or two may be taken up with mastering technical and notational difficulties and any influence on auditory abilities may not appear till later than with a child who is mature enough to profit from his earliest lessons.

Past Experience. The effect of music lessons or coaching may partly depend on opportunities of hearing good music in early childhood.

Present Home Conditions. A child's progress may be partly dependent on encouragement by his family. As far as private music lessons are concerned, the parents usually decide if these should be taken. But mere willingness to pay for lessons is not enough; the learner also requires understanding of the need for practising. While the individual who wishes to study from a book can do so anywhere and without disturbing anyone else, the music student depends on the tolerance of all within earshot. The child from a spacious home may have more than a mere financial advantage over the boy or girl from a crowded home with siblings who have little taste for classical music. In some cases the whole relationship between the child and his parents may be involved and whether or not he has music lessons may reflect the parents' aspirations for their children.

The Pupil's Interest in Music. This is not necessarily a constant factor; for some pupils who start enthusiastically may lose interest when they find that achievement calls for the sacrifice of leisure time and others whose first lessons are taken in deference to parental wishes may become extremely keen players or listeners. The varying pressure of school-work and other spare-time interests may be reflected in fluctuations of interest and of speed of learning.

<u>Teaching Methods</u>. How far the teacher's method suits any particular pupil and the general efficiency of the teaching method may affect the child's progress. A teacher who stresses the need to listen to the results the child is producing and includes ear tests along with instrumental lessons may be helping to improve the child's performance of auditory music ability tests. Again, learning a pitch variable instrument might be thought to improve pitch discrimination more than learning to play the piano or organ.

<u>Teacher-Pupil Relationship</u>. Particularly in the case of private lessons, the personality of the teacher may have a deep and lasting effect on the child's whole attitude to music and his willingness to persist and master difficulties.

An advantage of investigations of the effects of specific practice and of retesting is that the influence of other variables is less likely to intrude into the results. However, such training programmes usually have to be discontinued after a short period. Questions such as "Would further training have resulted in improvement, or further improvement? Will any gains achieved persist? Will they transfer to other musical activities?" are left unanswered.

The only readily available measure of long-term musical training is provided by instrumental lessons. However, only the fact of whether or not the individual has had lessons or the number of years these have continued is usually taken into account when comparing the amount of training with test scores. Except in the case of the Admiralty investigation (Newton 1959), qualitative estimates of the instruction received is not usually possible. Moreover, the child whose parents are willing to provide music lessons tends to come from a home where he has been exposed to incidental learning from a background of good music. His parents are themselves likely to be musical and to have passed on their ability by inheritance.

Some estimate of environmental influences can be inferred from comparisons of populations differing in sex, in socio-economic or school background, or in race, or cultural background, who are assumed to have varying opportunities to learn to play or to hear music. Some data on the blind are also available.

The viewpoint of the present chapter in considering whether musical ability can, by any means whatsoever, be improved differs from that of the test authors who are generally only concerned to show that test results are not unduly affected by the amount of listening and learning normal children are likely to have experienced.

Table XVIIa. Pitch Discrimination

Investigator	Ss	Type of training	Results (as reported by authors)	Wyatt's* comments
Buffum (Seashore, 1919)	28 8th grade pupils	40 min. specific & intensive practice for 20 successive days	Only 2 showed improvement. Average ability of class at end as at beginning	Groupings possibly too coarse to reveal improvements; Defective work methods may have remained unchanged.
Smith(1914)	106 children with high thresholds	Individual practice to aid them to distimguish different tone qualities and to form right habits of attention	No evidence of any improvement as a result of mere practice. But "cognitive" conditions can be removed by information, inducement to use best efforts etc.	Rapid improvement from 17.3 to 9.8 cps (for the 71 boys). From 17.7 to 7.8 cps (for 35 girls)
	54 poorest out of 200 adults	Diagnosis of individual difficulties; explanations and illustrations.	Improvements due to removal of "cognitive" difficulties.	47 improved rapidly
Wright (1928)	24 music college students	Seashore tests repeated every day for a week	Average score increased only slightly	Lowest 6 improved from P.R. 50 to 82 (6 points raw score) Highest fell from P.R. 95 to 91.

*From Wyatt's detailed and critical review of the literature on the improvability of pitch (1945).

Investigator	Ss	Type of Training	Results	Wyatt's comments
R. Seashore (1935)	12 adults with P.R. of 12 or less on Seashore pitch test	Average of 5.6 hours of individual practice; Ss told results; practice mostly slightly below most recent threshold achieved	10 improved, 3 to P.R. of 91, 81 and 70. 7 achieved thresholds of 3 cps or less	Longer and more varied training might have led to further improvements.
Cameron (1917)	6 psychology students	Several months daily practice in vocal matching	4 greatly improved singing accuracy & pitch discrimination at frequency practised, but little evidence of transfer. 2 had not improved	Improvemnt <u>not</u> due merely to removal of "cognitive" conditions, or would have affected unpractised tones
Capurso (1934)	a. Experimental group: 4 with highest Seashore pitch scores, 3 with lowest scores. Control group 3 with highest, 3 with lowest (both out of 58 adult music) students.	½ hour practice on alternate days for 7 weeks of a) associating piano interval with other auditory stimuli or mood word; b) discriminating higher of 2 tones on forks. Ss told results.	Only lowest 3 of E group improved significantly.	

Investigator	Ss	Type of Training	Results	Wyatt's comments
Capurso (1934) contd.	b. 2 subjects	Similar to above for 6 months.	1 improved only from P.R. 3 to 17 "due to diversion of interest". 1 improved from P.R. 6 to 94 and learned to sing scale without piano.	
Wolner & Pyle (1933)	7 highly pitch deficient children 5th to 7th grade	20 mins. a day for 81 days individual practice in listening, imagining & singing single notes, intervals and scales	All 7 learned to discriminate 8th, 5th, 3rd, whole & semi-tones. 2 could sing perfectly songs and scales; 2 could not sing perfectly but had improved tremendously.	Even after 81 days W. & P. not certain Ss had reached "physiological limit" to improvement.
Connette (1941)	23 adults	5 days individual practice. Demonstrations with fore-knowledge of correct answers. Ss told own results after each response.	Ss in upper half on initial scores improved by 29%, Ss in lower half by 58%.	

Investigator	Ss	Type of Training	Results	Wyatt's comments
Wyatt (1945)	a. 8 music students b. 8 arts students	12 x 50 mins. individual intonation & pitch discrimination practice; Ss told results, given demonstrations with foreknowledge. Correction of constant error. Use of chromatic stroboscope to provide musical check on Ss ability to match a standard tone.	a. Seashore score improved by mean of 7.75. Wyatt score improved by mean of 12.25. b. Seashore score improved by mean of 4.50. Wyatt score improved by mean of 14.95	
Sakurabuyaski Sato and Uehara (1957)	(Not stated in available source)	350 pitch discrimination judgments each day for 6 days	All improved except those with IQs below 90.	
Leontiev (1957)	Tone deaf children	At 8-10 sessions, Ss had to attune voice to pitch of certain sounds fed as continuous notes into earphones; after S had begun to sing, sound was switched off and he continued to sing independently. Later intervals of up to 6 secs. introduced between sounds and response.	Improvements were recorded for all Ss.	

Investigator	Ss	Type of Training	Results	Wyatt's comments
Skinner (1963)	Tone deaf children	Teaching machine with graded programme from coarse discrimination	Progress from coarser intervals to discrimination of tones and semitones.	

Table XVIIb. Rhythm and Time Discrimination

Investigator	Ss	Type of Training	Results
Klauer (1924) cited Farnsworth 1928	(not stated in available source)	2 months marching, clapping, beating time etc.	E group showed no significant improvement over controls. (But C group of lower P.R. and retested after shorter time.)
Coffman (1949) cited Lundin 1953	E and C groups from 24 8th grade and 10 music students with lowest Seashore Rhythm scores.	10 to 16 hours of rhythmic training, including Eurhythmics.	E groups had improved "remarkably"; C groups showed little change.

Investigator	Ss	Type of Training	Results
Henderson (1931) cited Lundin 1953	9 piano students	5 days practice with patterns on the Seashore rhythm meter.	"Distinct progress" made.
Skinner (1963)		S required to tap in unison with rhythm presented by teaching machine	Skill improved from very approximate agreement to skilled performance.
Ross (1914)	8 subjects of average ability	Seashore-type time test repeated 7 times on successive days. 50 trials each day at the two time steps closest to the Ss threshold of the day before	Marked improvemnt. Range of average gains, 11% to 50%

Effects of Retesting and of Specific Coaching

Experimental studies of the effect of retesting and of special coaching on sensory capacities are summarised in table XVIIa and XVIIb.

Much more attention has been given to pitch discrimination than to rhythm and time discrimination, but some of the conclusions which emerge from the investigations of the former may also apply to the latter.

The general conclusion which an inspection of tables XVIIa and XVIIb suggests is that sensory capacities can be improved in most cases but only under certain conditions viz.:

1. Mere repetition of a test will not necessarily lead to improved results. In fact, the abler subjects may become bored and make lower scores.

2. Explanation of what is involved in the concept of pitch, cues as to the best working procedure, demonstration with foreknowledge of what the subject is going to hear, knowledge of which answers are correct appear to help to improve scores.

3. Prolonged training at a given frequency, while it usually improves discrimination and vocal reproduction at that pitch, may not transfer to other frequencies. The practical corollary would seem to be that the emphasis should be on relative pitch and that practice at various frequencies should be included in any remedial training programme as soon as the larger intervals can be discriminated at all.

4. Training may have to continued for a long period. Some of Smith's subjects were still improving their scores at the twelfth trial, Wolner and Pyle were not certain that they had reached the limit of their subjects' capacity for improvement when the experiment was discontinued. Plateaux of learning may be encountered, but once surmounted, further progress may be rapid.

Considerable efforts have to be made to keep the subjects highly motivated.

5. The training must be adapted to the needs of the individual. This would make remedial work extremely costly in time. However, if remedial training in pitch discrimination were ever undertaken on a large enough scale to enable the pupils to be classified into small groups with similar difficulties, no doubt individual methods could be applied to small groups. The most helpful training procedures were those which encouraged the use of auditory imagery and motor participation (Wyatt 1945, p.41). Postural attitudes appeared to have some significance, but individuals differed as to what helped them. Thus some of Smith's subjects required to give the closest attention for successful discrimination, but others found that this caused nervous strain which led to mistakes.

Wyatt considered that improvement might entail an increased readiness to imitate tones inwardly, but pointed out that even "elementary" pitch discrimination may involve a complex of psychological functions including sensory, perceptual, imaginal, motor, intellectual and affective processes. Wyatt's evidence is convincing in refuting Seashore's view that the physiological "bedrock" limit of an individual's pitch discrimination can be readily ascertained by testing or retesting. In the absence of further evidence, she urged the idea that physiological or neurological changes might occur should be retained as a possible explanation of the improvement (i.e. that all the improvement was not due merely to the removal of cognitive difficulties, as Seashore supposed).

Granted that gross pitch deficiency can often be improved by suitable methods, the question then arises, "What has been achieved that is musically useful?". As mentioned in Chapters II and VII, the findings of Kalmus (1948) and of Fieldhouse (1937) suggest that tonal memory may be a more important factor in tune deafness than pitch discrimination. Those subjects who learned to sing a scale and musical intervals in tune, without the piano, would seem to have acquired the absolute essential basic skill required for further progress. They would now be able to undertake such a course of ear-training as is described in Lawton's 'Foundations of Practical Ear Training' with some hope of being able to master the first few exercises in pitch. Singing is recommended by Lawton because of its value in focussing the student's attention upon the sound alone. Her first pitch exercise requires the student to play* (on the piano) and sing up and down the scale, sounding each note before singing it. Even this would prove difficult to many pitch deficient subjects before remedial training. In the second exercise the student has to sound the key-note on the piano, then sing up the scale, testing the accuracy by playing each note after it is sung. This cannot be done without a clear memory for the relative pitch of the second, third, fourth etc. notes. But if this exercise and succeeding ones on the tonic chord can be mastered - and Wolner and Pyle's subjects should have been able to perform them successfully after their course of training - then the way would seem to be open to sight reading three or four notes (given the tonic) in major keys, then in minor keys, two-part melodies and for exercises in recognition of cadences and in simple dictation. Lawton, like Wyatt, stressed the importance of careful listening to establish a clear mental concept that will remain in the memory and can later be reproduced vocally and eventually by "silent mental repetition" (probably accompanied by sub-vocal movements).

The importance of being able to sing in tune is here emphasised because, from the point of view of improving pitch defects, it makes practice away from the piano very much easier (and provides overt evidence of the effects of training) But as Fry (1948) pointed out, there are instances of very

*or for the teacher to play. Lawton's course was primarily intended for adult piano students who were weak at aural work.

musical people who are well able to recognise tunes but who are, nevertheless, incapable of singing in tune. However, Pollock (1950) found 45 monotones significantly inferior to 45 normal children in both Wing's memory test and the whole Wing battery. The sensory side is, Fry says, the primary mechanism since it can act without reference to the motor mechanism, whereas the satisfactory working of the latter is possible only by the operation of a feed-back circuit from the sensory side. It is probable that it is where defects are largely on the motor side that the methods such as Brody's would work. Brody (1949, cited in Encycl. of Educ. Research) sought to improve such factors as posture, respiration etc. and thereby claimed to have succeeded in teaching non-singers to carry tunes.

Leontiev and Skinner make use of modern methods to ensure their subjects form a clear concept of a simple stimulus. Tomatis has designed equipment by which he claims to be able to train people to sing in tune by correcting electronically the faulty response of their "directive" ear. A Benedictine monk, after a course of listening through earphones to his own voice distorted electronically to compensate for the short-comings of his ear, is reported to have learned to sing in tune. These methods might offer economical means of remedial training.

It is not clear how such improvements might transfer to the playing of pitch-variable instruments. Capurso's subject whose pitch discrimination P.R. improved from 6 to 94 was said to have found her discrimination of violin tones had improved. Dolmetsch claimed that ordinary children could quickly be taught to play a stringed instrument in time and with good phrasing. He did not, however, mention intonation If a child can sing in tune or has at least a clear mental concept of the pitch of the notes he is trying to produce, he has the prerequisite for good intonation. Otherwise, like Alexandre Dumas, he may not be able after three years even to tune his violin. Dumas's teacher "was obliged to recognise my allergy to music and tell my poor disappointed mother that it was simply stealing her money to continue to try to make a musician of me" (Dumas, trans. A. Craig Bell, 1961).

Unfortunately, no information seems to be available about the subsequent history of any of these pitch deficient subjects. Leontiev attempted subsequently to train his subjects to reproduce very simple melodies, but did not give details of the results. It seems reasonable to suppose that those who learned to sing one or two tunes with perfect intonation would be able to increase their repertoire, but how far they could progress with other activities (such as holding a part against an upper voice) is less certain. There is evidence from carefully carried out experiments that the singing of single notes, intervals and phrases by young children can be improved by training and that the effects of the training persist.

Thus Jersild and Bienstock (1931) trained 18 children (average age 3:2) in the singing of single notes and of intervals during 40 ten minute sessions spread over 6 months. A significant difference was found between the final scores of the experimental subjects and those of 18 other children paired with them. When the same children were retested two years later (Jersild and Bienstock, 1934) the trained group had retained a reliable superiority over the control group.

The initial scores made by the three-, four- and five-year old children who took part in Updegraff, Heileger and Learned's investigation (1938) have been quoted in Chapter IV, p. 150. After 15 days, after 30 days, and in the case of the five-year olds, after 40 days, the children were retested. Definite, consistent improvement was found among the children given training. The control group improved slightly, if at all. In the case of the three-year olds, the curve of improvement was slightly steeper between the fifteenth and thirtieth periods than earlier. The same was true of the four-year olds in the phrase test, but not in the easier single tones and interval tests. The five-year olds improved more rapidly during the first fifteen days. The improvement at all ages continued throughout the period. One of the five year old boys in the experimental group was at the beginning "practically a monotone". He improved during the course of training, though his record materially affected the mean scores of the group.

The interest of the experimental group in the actual training procedure remained high throughout Jersild and Bienstock's experiment, though no systematic method of estimating interest was used. During the Updegraff, Heiliger and Learned investigation, both the experimental and control children were carefully observed during periods of musical activities at the school. The degree of interest and voluntary participation shown by the children was carefully recorded on an observation blank and independent ratings made by the experimenters and teachers. At every age the children of the experimental groups showed increasing interest in the musical activities of the school. The interest scores of the control group reflected little or no change in attitude. By the end of the training period the difference between the two groups was statistically significant. The normal music training at the nursery school attended by these children, though not inferior to average may have been beneath their capacity to respond, thus allowing considerable scope for the trained group to show improvements. It is also possible that the gains made were in the nature of accelerated development. If they lasted, or were boosted by further training, the final result might be that the children would reach musical maturity at an earlier age than normal, but that their ultimate maximum of development might remain unchanged.

If the experimental group could have been given further training e.g. in recognising which note in a short phrase had been changed on a second playing, it does seem likely that such long-term practice would tend to improve performance of tests such as Drake's and Wing's Memory test.

Some empirical evidence is available on the effects of rather short-term specific coaching and of aural training on tests of musical ability based on musical material.

Wing (1941a, p.214) reported that 25 boys, aged 15-18, improved their initial score by 4.1% when a second testing was preceded by a 20 minute lesson and discussion on the material of one of the sub-tests. A control group gained only 3.4%. This very small amount of improvement with practice compares very favourably with research on intelligence tests. Practice on identical tests generally produces a rise of about 5 IQ points, on parallel tests nearly 5 IQ points. Coaching with practice at taking complete tests can produce quite large gains. The total average gain from 2 practice tests plus a few hours coaching is estimated by Vernon (1960) to be about 9 IQ points for the majority of British town children.

Familiarity with the music of the test items appeared to have little influence on Wing scores (Wing, 1941a, p.208 and 1948) even when the proportion of known items was quite large. Most boys from a group of 100 who had considerable experience of music knew only between 5 to 15 out of 80 items, but a few knew up to 45. Yet the percentage of correct answers for known and unknown items was almost exactly the same.

Drake (1943) gave both forms of his Musical Memory test to 14 college students (presumably majoring in music) and to 58 psychology students. After the experimental group had attended an ear-training class for a term, both groups were retested. The trained group had improved their mean score from 27.72 (number of mistakes) giving a P.R. of about 50, to 19.43, which is equivalent to a P.R. of 80 from the norms for "Music Students" (see Chapter I, p. 39). The 58 control students had reduced their average number of mistakes from 46.24 to 42.02, representing an increase of P.R. of 10 points, from 50 to 60, on the norms for "non-music students". The increased improvement due to training, as opposed to mere retesting, was not significant statistically. It is a pity that the two groups were not more comparable in past experienc As the control group had evidently much less previous training (though equal in initial percentile rank on the different set of norms) it is possible that if the experimental subjects had been chosen from them, the scope for improvement by ear-training might have been much greater. But no doubt only the music students had time-tables which included ear-training.

Gordon (1961) investigated the effects of specific coaching on the performance by 14 to 15 year old children of the tw Drake tests. He chose 10 children whose initial P.R. ranged from between 50 and 75 and 10 whose P.R. ranged from 1 to 36, on the Memory test.

Five from each 10 were selected to serve as the experimental group. 17 half-hourly instruction periods were devoted to the practice of musical phrases similar to those used in Drake's Memory Test. The subjects were taught how to listen for the different types of changes in the phrases. 3 periods of training were given over to the rhythm test. Neither the control nor the experimental group was receiving outside musical instruction. Both groups were retested at the end of the experiment which had lasted one month. The results of the first musical Memory testing were used as a control measure to equalise high or low initial scores. The difference between the two groups when their adjusted post-test means were compared was 4.32. When analysis of covariance was applied, the result was found not to be significant at the .05 level. Gordon had tried during the training periods to offer instruction that would help both the high and low scorers (the children were unaware of the results of the first testing). The analysis of covariance did not confirm the hypothesis that training might be more effective with the more musical subjects. No significant difference was found between the adjusted means for the rhythm test - in fact the control group had gained slightly more. But, as was mentioned in Chapter I, individual scores for the rhythm test showed extreme gains and retrogressions for both groups. Among the Experimental group, 7 subjects gained from 1 to 93 points (median 20) and 3 lost 5, 74 and 89 points respectively. Two of the control group improved their scores and 8 showed losses of from 4 to 70 points. Several children made more than the 91 mistakes allowed for in Drake's norms. Three of the high scorers and 4 of the low scorers in the Experimental group made sizeable gains with the Memory test, but two of the low scoring controls also gained 19 and 29 points respectively. At the end of each week of the training after the second week, Gordon administered a memory test of his own modelled on Drake's. These informal tests gave some indication of growth in progress. Gordon commented that larger groups might have yielded significant differences. One might also wonder if the training would be more effective if the low and high scorers could be given separate sessions. Longer term instruction might lead to greater improvements. Interest might be sustained by including the study of suitable themes and variations from published music.

While the evidence summarised in this section suggests that aural capacities can be improved, it would be interesting to have details on the individuals who improve only slightly. Even one or two of Wyatt's subjects increased their scores by rather small amounts, in spite of all her exceptional efforts. It would also be important to discover how far improved aural ability would extend to the appreciation type of test.

The Effect of Instrumental Lessons

Reference has already been made in Chapter I to various studies of the extent performance on various music tests may be affected by instrumental training. As a rough generalisation it might be said a) that many subjects with no formal musical training make higher scores than do subjects with considerable training (Farnsworth, 1928; Wing, 1954), but b) subjects who have had music lessons do tend to make superior scores. The question arises whether the superior scores of the latter are due to their training or to selective factors i.e. only the more highly talented continuing to learn music.

Kwalwasser (1955) considers that "it is much more rational and realistic to maintain that training is a by-product of talent (than that talent is the product of training), for those possessed of talent seek and receive instruction". As mentioned in Chapter I, the average score of some 4,200 children aged 10 to 19 on the K-D tests was 11.25 points higher in the case of those who had received six months or more training.

Wing's figures (1948 and 1954) showed that there was little difference between the percentage of talented children and of untalented children who were receiving lessons, but that with adults, 62% of those with the highest marks had received instrumental lessons and 10% were self-taught players. Wing explained the larger proportion of musical adults having received lessons in terms of their being free to follow their own interests, rather than their parents' wishes, on the matter of lessons and the more talented adults tending to be more interested in music. Wing (private communication) suggest that a positive association between talent and receiving lessons might now be found even among children, since parents and teachers nowadays tend to be on the look-out for talent and children who show aptitude are more likely to be given the opportunity of learning an instrument. Wing himself classified his subjects merely into those who had lessons and those who did not, irrespective of the length of training. Newton (1959; see also p. 50) however, used three categories between 0 and 15 terms of RMSM instruction and stated that it was "improbable that finer sub-groupings would yield a more significant connection". Newton's evidence on the lack of effect of tuition of a fairly standard type on the Wing tests would seem to be very difficult to refute even by a zealous environmentalist. Standards of selection to a Service School might be supposed to vary from time to time but are unlikely to produce exactly compensating effects. It also sounds improbable that the boys were too old for their musical aptitude to be affected by training, though they were still young enough to become proficient musicians. But it would, of course, be desirable to check such results by testing experimental groups of various ages, matched as far as possible with control groups of similar initial aptitude, intelligence, interest in music and facilities for learning, before music

* Holmstrom puts forward this argument (see p. 443).

lessons were commenced, and to retest after various periods of instruction.

Some other problems connected with music lessons were studied by Graves (1947). She had herself taught music and lived in a community where the giving of music lessons was a flourishing industry. She attempted to find out whether the child having lessons might gain satisfaction in playing because of native ability and a real pleasure in music, or whether he tried to excel in music to offset feelings of insecurity in other areas; and whether parental attitudes towards studying music might reflect genuine interest in the child, or a desire for social prestige due to the child's success, or unfulfilled parental ambitions projected upon the child. She compared two groups of children aged between 9 and 17, matched in age, intelligence, sex and school grades and differing only in that one group was taking music lessons. She found that the children taking lessons were <u>not</u> victims of parental overdirection. On the contrary, having music lessons was associated with being in harmony with one's family, not having lessons with being in conflict with one's parents, one's own ideals and one's friends' behaviour, as measured by the Spencer Conflict Score. There was no significant difference between the two groups of children in their attitude to music, except when the child's belief concerning whether his parents wanted him to have lessons was taken into account. The parents whose children were learning to play estimated children's joy in playing as much greater than did the control group's parents. Of the 25 children of the experimental group where data were collected from both parents, only 3 fathers had not had music lessons themselves, whereas 17 of the control group's fathers had not learned music. The control group's parents had not liked playing, but the experimental group's parents had enjoyed playing. Graves did not test the parents' musical ability, but the experimental group's parents would probably have made higher scores. The experimental group made significantly higher scores than did the children not receiving lessons on the Seashore Pitch and Tonal Memory tests and on both the tonal and interest parts of the Gaston Music test (see Chapter I, p. 55), but not on Seashore's rhythm test. Graves did not put forward an explanation of these differences, but commented that it was difficult to believe that the families sorted themselves so definitely in terms of inborn musical aptitude, that only children from such families, who also ranked high in musical aptitude, were given lessons. It was clear that the experimental group's experience with music was much wider than merely taking lessons.

Effects of Incidental Learning

Wing is the only test author, to the writer's knowledge, who has published data on the possible influence of the music played by other people at home on a child's test scores.

Wing (1941a and 1948; see also p.208 above) found that there was a significant difference between the scores made by 333 boys who had music at home when their parents played but not when persons other than their parents played. He also showed that there was only a very moderate association between interest in music and ability to perform his tests (an approximate correlation was about .30). In any case, as far as awakening the child's interest was concerned, parental playing was very little different from the playing of others. He concluded, therefore, that the most likely explanation of the association between the child's ability and parental playing was that the child's ability had been inherited. It may well be the true reason, but it is not the only possible one. Parental playing may be a more potent influence on the child merely because it has gone on for much longer or because the parents have more prestige in the eyes of the child. Wing rejects the latter interpretation, though it could be argued that adolescent boys might have been more influenced by the playing of their parents than by the practising of their sisters. Wing does not state how the group of "non-parents" was made up, but it may have included a number of lodgers (Wing - private communication) as well as other blood relatives, siblings with perhaps some grandparents or uncles and aunts. (In so far as the observed significant difference was between the parents' playing and the playing of less close relatives, as opposed to unrelated strangers, that would tend to strengthen the hereditarian argument). Wing's percentages for adolescents who give up playing (1948, p.73) and for adults who have received music lessons (1954) do confirm that parental playing is a rough indication of musical ability. However, almost 25% even of Training College students with above average ability had never received lessons nor tried to play on their own. Moreover, many of the parents who played may have had little real ability.

However, Wing's main purpose was "to evolve a satisfactory series of tests, and the problem of the inheritance of musical capacity entered only in so far as it was necessary to make reasonably certain that the child's ability to perform the tests was not unduly influenced by opportunity to hear music" (Wing, 1948, p.82).

Wing excluded separate considerations of the influence of radio music. This might be less defensible in the 1960s than it was in the late 1930s when Wing was collecting his data. The following figures show the increase over the years in the number of radio and television sets for which licences were bought in Great Britain and Northern Ireland:

Table XVIII

	Licences issued Radio	TV + Sound
1927	2½ million	
1932	4½ "	
1939	9 "	
1946	10½ "	
1960	15 "	10½ million

Expressed as a percentage of the families living in Great Britain and Northern Ireland, 92.36% had sound radio and 64.65% TV in 1960.

There is little real evidence of the effects of broadcast music on musical ability. The more valid tests were perhaps standardised a little too late to show whether there has been any rise in musical ability analogous to the increase in IQ which tends to occur when children are removed to a more highly stimulating intellectual environment. It is reasonable to suppose that broadcasting has tended to make the musical environment more uniform since nowadays even the child from a very poor home can see and hear orchestral instruments at a very early age if he so wishes. No doubt the greatest effect will be on children with a high degree of talent and interest since they will learn more readily through their ears. As stated in "Music in Schools" (Min. of Education 1960) "when a child comes to school he normally brings with him a considerabl variety of musical experience. Much of this will doubtless have come from sound radio and television programmes ranging in suitability from such series as <u>Listen with Mother</u> to material of a more sophisticated character preferred by the older members of the family". However, much broadcast music doubtlessly falls on inattentive ears. As Constant Lambert (1934) complained "Never has there been so much music-making and so little musical experience of a vital order". The child trying to complete his homework against a background of music may seem to be receiving training in <u>not</u> attending to music. Though reading Greek passages to a sleeping child has been claimed to aid later recall(Burtt, 1932, 1937) little effect could be expected on a waking subject trying to concentrate on something else. As mentioned in Chapter V, selectivity of the stimulus to be perceived may occur even at the receptor stage.

Attention at the best of times is notoriously fluctuating. A long-term attitude of willingness to listen would appear to depend largely on central facilitation, which in turn depends on past listening experience (Hebb, 1949). Attention and interest are highly likely to interact. The greater the interest the more closely the individual is likely to attend, and the longer his attention will tend to last. As Hebb points out, interest tends to prolong the phase sequence and to avert fatigue or sleep. Conversely, the more the individual attends, the more he is likely to perceive details which will sustain interest, at least in the better type of composition. Chandler (1934) found, as might be expected, that music-lovers usually enjoy most the music which is within their range of appreciation but near the upper margin. Their interest tends to be aroused by music which poses some problem of appreciation (perhaps by being slightly more discordant than is currently acceptable to the individual's ear), to increase to a maximum and then to decline as the "problem" is solved or the novelty wears off. As Medley (1943) pointed out, mere concentration is not enough. "What we must learn is not so much concentratin our thoughts on the music as silencing them altogether: quietening our minds and becoming really receptive". This may be rather easier at a concert, since the journey to the hall and settling in one's seat may serve as a break from thoughts of the day's work. At home, a concert may become something too narrowly sandwiched between finishing homework and getting ready for bed. The danger of broadcast music is that much-played pieces may become overfamiliar, or heard superficially so often as to dull the appetite for any real appreciation. "The objection to a constant broadcast stream of light music is not that the music is light" (if music is to serve merely as a background, then "serious" music is too good for that purpose), "but that it is hypnotic and its associations maintain a constant pattern of mild titillation" (Grey Walter, 1953, p.47).

The child whose parents set an example of ~~either~~ good listening is likely to value music. However, if the child's interest in music can be awakened at school or by private music lessons, "the radio provides great opportunities for its development" (Wing, 1941a, p.363). So long as the rest of the family is willing to have even such programmes as "Your 100 Best Tunes" or "These You Have Loved" switched on and are not making a noise or talking, the child can still listen, even if his father is filling in his football pools coupon, his mother knitting and his sister reading.

Individual differences in how far the listener finds his interest in a composition lowered by familiarity are noted by Bruno Walter (1961) "There are people who are ever more deeply touched by every renewed encounter with Schubert's 'Unfinished Symphony' and others who when they listen to the Benedictus in Beethoven's Missa Solemnis feel scarcely more than 'I know this already'..." "As regards the latter we artists must try, time and again, to burst open the elderly crust they have acquired, or with which many of them may have been born". Musicians, also, are liable to fall into routine interpretations Bruno Walter states that the more often he had conducted a work, the more care he had to take to revive in himself the feeling of his first enthusiasm for it.

To sum up this section, radio music will tend to reinforce the musical influence of the home and to be greatest where the parents are musical or interested in music and the children sensitive to musical stimuli.

Sex Differences

In so far as girls receive more encouragement to learn to play or to take an interest in music, comparisons of the sexes may provide indirect evidence of the effects of training.

On the whole, male subjects tend to make about the same scores as females on musical ability tests. Thus, Seashore, Lewis and Saetveit (1960) reported that the sex "differences were found to be very small and inconsistent from one level to another. Combined sex norms (for the Seashore tests) were therefore formulated". Drake (1957) reported that no significant differences between the sexes had been found on his rhythm test, while on the Musical Memory test, there was a slight superiority for girls - amounting to about 1½ points for either form alone. The difference was too small to show in the norms. Wing (1948) obtained approximately the same average marks for both sexes at each age (but see below), so that adjustments for sex were not required. The table on p. 270 summarises the differences on the K-D tests, as described by Kwalwasser (1955).

These differences are quite small. Larger differences were found by Gilbert (1942) who tested 1000 College students with the K-D tests: the mean for 500 women 2 208 and for 500 men = 202.5 (out of a maximum score of 275). However, the female group had received about three times as much instrumental training as the male group. He attributed the superior scores of the women to the greater amount of their

Table XIX. Sex Differences on Performance of the K-D Tests

Subjects	Males superior	Females superior	x male score	x female score
4247 American children grades 4 to 12	Time, intensity* and quality discrimination	Rest of K-D test	179.70	182.05
3588 boys, 3833 girls grades 4 to 12			179.05	181.25
500 University students	Quality, intensity and time and pitch discrimination	Rhythm, melodic taste, tonal memory, tonal movement, pitch & rhythm imagery	197.31	202.54
700 junior high school children			178.3	179.4
6000 European children	By 20 points in Hungary	By 14 points in both England and Italy	191.06	191.49

*According to Kwalwasser's text but not according to his figures.

training and not to innate superiority because a) when only the untrained members of the two sexes were considered, the difference disappeared, and b) when the subtests most susceptible to training were taken out, the differences were greatly reduced (and in the case of the untrained subjects actually reversed).

Though Wing (1941a and 1948) found that no adjustment for sex differences was required to the norms for his battery, he reported that after the age of 14 girls seemed rather better than boys at the appreciation tests, though the two were still equal in performing the first three tests. The difference amounted to about 4 out of 80 marks. Discussing possible reasons for the difference, Wing (1941a, p.402) rejected both errors of sampling and differences of training, since the children came from similar districts and homes, also the same phenomenon was noticed in a coeducational school, where the two sexes had the same teaching in mixed classes, and where they were of similar IQ and home environment. Moreover, a difference of training or of interest could be expected to have at least as great an effect on the first three tests. Two possibilities which Wing suggested might repay further research were the change in the boy's attitude to music which might accompany the physiological changes in the larynx when the boy's voice breaks, and the supposition that girls have a greater preponderance of introverts after adolescence and "that introverts make better listeners to music which requires appreciation". Another possible explanation might be in the earlier puberty of girls i.e. girls are merely more advanced in their appreciation of music than are boys. However, the results of the factor analysis (see Chapter XIII) might be interpreted as supporting Wing's theory of more complex factors being involved in the sex differences in the appreciation of music.

Very briefly, Wing's argument on the connection between introversion and women's interest in listening is as follows: introverts tend to find their chief delight in music as listeners (or as composers if they have creative talent). Women are, on the whole, more introverted than men (Wing (1941a p.462) quotes Jung's statement to this effect). Therefore, women can be expected to make better listeners than men. As Wing points out, it is obvious from a visit to any concert that women do form the greater percentage of concert audiences. This cannot be ascribed only to the fact that they have more free time, for it is found that the percentage of males in an amateur orchestra is far higher than at a concert. Wing attributes the larger percentage of amateur male performers to a personality, rather than a musical, difference, since men are more extroverted than women and musical extroverts tend to gain more enjoyment from performance than from listening. Wing like Jung, recognises, of course, that most people are of mixed personality and that with musicians "there will be no sharp demarcations" (Wing, 1941a, p.453).

It may well be true that sex differences in music are related to inherent biological differences and not merely to differences of opportunity to learn and of social expectancy. Cultural factors themselves may to some extent reflect the biological differences. In so far as they were inherent, such differences would tend to persist if the music education and opportunities offered to both sexes were equalised.

Even if the adolescent girls' higher scores on tests 4 to 7 depend ultimately on inherent biological differences, it must be through interaction with their musical environment that a difference in attitude could operate. Presumably, girls are either willing to devote more time to listening to music than boys, or they listen with greater attention, or are more emotionally responsive. The differences in their scores are, in any case, quite small. As Allport (1937, p.517) remarked on judgments of personality "All in all, there are plenty of reasons to account for woman's superiority... The wonder is that their superiority over men is not more marked than it is". The absence of greater sex differences in musical ability would tend to argue for the relative ineffectiveness of environmental influences.

Valentine (1919) reported that the introspective remarks of 146 subjects appeared to show that there were more men than women who were deeply sensitive to the impressions of musical intervals. Moreover, the proportion of judgments of high aesthetic judgment value made by 52 men was higher than among 84 women. This might be partly due to Valentine rating "subjective"judgments low. (He rated perception of the "character" of intervals higher than musical "association" of the interval played with a following one imagined by the listener). Possibly, too, women might find the task of judging single intervals lacking in emotional appeal or musical interest. This (as Farnsworth, 1931, implied) might also explain why sex differences are sometimes found in the performance of tests like the Seashore. Such tests lack "musical" interest, but boys might find them of scientific or experimental interest. As far as interest in music is concerned, a much wider difference (5 to 8 points compared with 2 or 3) separates the sexes on Gaston's interest inventory than is apparent in the norms for the tonal items of his test (described on p. 54 above).

At the musical ability level of the ordinary schoolchild, girls appear to do better than boys both in musical knowledge and in class singing. Reporting the results of testing over 4,000 children with the Kwalwasser-Ruch Musical Achievement Test, Kwalwasser (1955) stated that the 4th grade boys were only 5 points behind the girls, but by the 8th grade their mean score was lower by nearly 30 points (equal to two years). Semeonoff (1941) found, however, boys achieved rather higher scores on his adaption of the Kwalwasser Music Information and Appreciation Test than did girls. Boys were significantly better at selecting words which gave the best description of a composition; girls at preferring the acknowledged master-piece rather than two pieces of less musical worth. A much higher proportion of boys was found among children judged as poorest at singing by their teachers and a much lower proportion of boys were among children selected as the best singers in the class (Kwalwasser 1955; see also Chapter I above). Though Bentley (1963) found no significant difference between the sexes in musical ability as measured by his tests (see Chapter I), the percentage of "monotones" among boys was much higher even at age 7 and it failed to decrease with age as much as did that of girls. At 12, 7% to 8% of boys, but only 1% to 2% of girls, were categorised as "monotones".

At higher levels of achievement, far fewer women than men win distinction. For instrumentalists, this may be partly due to the prejudice against women players which has died only gradually (Tillis, 1960). A woman of talent may encounter prejudice when she seeks employment in an orchestra. There would seem, however, no such barrier to a woman composing. Classes in harmony, orchestration and composition have been open to women for many years. It seems unlikely that female students whose compositions showed real merit would be refused tuition and encouragement. Yet Dame Ethel Smythe and Elizabeth Lutyens are among the very few women who have become well-known as composers. There may be here some genuine sex difference. Perhaps the highest level of musical genius is much more rarely found among women, as seems to be the case in literature and painting also. However, there does not seem to be in the musical world even the equivalent of the numerous women novelists who are usually competent and sometimes highly distinguished.

Differences in Type of School and Socio-Economic Background

There are several pieces of evidence to consider:

The norms made by children at Higher grade Secondary schools are about 10 marks (equal to 3.3 years of Musical Age) above those for children at Secondary Modern schools (Wing 1941a, p.390).

Burt (1909) found that 13 Preparatory schoolboys (aged 12:6 to 13:6) were better at the discrimination of pitch than 30 Elementary schoolboys. Half of the latter were choristers and many were learning some musical instrument, while 5 out of the 13 Preparatory schoolboys neither sang nor played and the whole group had received much less training in music.

At a Preparatory girls' school in which nearly every girl over 7 learned some musical instrument and all of whom heard good music fairly often, the girls developed the power of discriminating between concords and discords as much as three years earlier than did Elementary schoolchildren. By the age of 9 they gave an order of preference for musical intervals almost identical with that given by adults (Valentine, 1919, p.106).

A class of Elementary schoolboys gave almost identical averages, <u>except</u> in aesthetic choice tests, as did a class of secondary schoolboys. They spent more time on music at school than the secondary schoolboys, but evidently did not hear so much good music at home (Wing, 1936, p.91).

When Gilbert (1942) reanalysed his data, classifying by socio-economic status instead of by sex, he found that the highest college scored 209.8 points in the K-D tests, the middle one 203.7 and the lowest 200.6. The higher the socio-economic status of the College, the greater the percentage of students who had received music lessons. When only untrained students were considered, the mean score (197.0) was about the same at each level.

The present writer concluded from a previous investigation (Jamieson, 1951) that a good socio-economic background seemed, as might be expected, to increase the number of songs children knew and the number of tunes they could recognise. However, adverse social conditions might be counteracted by really enthusiastic efforts to foster music on the part of the school. This was shown by the comparatively high scores made by the children, especially the girls, in a working-class district who attended a school where the headmaster was particularly keen on music. The number of tunes recognised, but not the number of songs known, showed a moderate correlation with IQ.

Several explanations might be put forward of the above data:

1. The higher class children do better at music tests because they are more intelligent. This was probably partly true of Wing's and of Burt's results. Many of Wing's

Secondary Modern children were probably at or below the level where IQ affects performance of the Wing tests (see also Chapter III, p. 115). Pitch discrimination appears to be rather more affected by intelligence than other musical abilities (see Chapter III). An estimate of the general ability of Burt's subjects correlated with pitch discrimination .40 for the Elementary schoolboys and .37 for the Preparatory schoolboys. Valentine's Preparatory schoolgirls could be expected to be above average in intelligence*. However, this explanation does not fit Gilbert's data, since the College with the lowest socio-economic status had a particularly high scholastic standard. Whether Wing's aesthetic choice tests are more or less likely to be affected by intelligence than are the first three tests is still a moot point. The preliminary results of some current research suggest that they may show a somewhat higher correlation with intelligence (Cleak - private communication). The results obtained by the writer (Chapter XII) show little difference.

2. Children from better homes have more opportunities to learn to play and to hear good music. This would seem to apply to Valentine's and to Gilbert's results. Gilbert,

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* Valentine himself has recently (1962, p.220) expressed the view that "it is just possible that superiority in general intelligence may have helped these Preparatory school girls, of only 6, 7 or 8 in understanding what was required of them" He also wonders "whether very different results from mine would be found nowadays with children in our junior or even infant schools in view of the much more frequent hearing by children of music owing to the radio and the greater place given to music in the primary schools, than was the case when I did my experiments over forty years ago".

however, rather oversimplified the picture by neglecting the probability that many of the students who had learned music had inherited their talent from musical parents. Appreciation of the harmonic conventions of Western music possibly develops with age (see Chapter IV). Its development is likely to proceed more rapidly, the more the child can hear good music. Valentine thought that his results were due largely to the Preparatory School girls' early training. It might be a case of accelerated development, especially as the less fortunate children eventually reach the same standard. Wing himself recognised that "musical taste is probably absorbed unconsciously if the child is given suitable surroundings (1936, p. 91).

3. Children attending better schools and from more cultured homes are more likely to have inherited musical ability. While one would expect that musical ability would be less closely related to socio-economic status than is intelligence, yet to some extent this is probably true. After all, though music may not be so highly valued by the community as most musicians might like, music teachers and performers do enjoy a reasonably high social status. Possibly, too, being musical is an asset to a womah and there might be some tendency for musical women "to make good marriages" from the point of view of social status.

Differences of Race or Cultural Background

When music tests are applied to subjects of non-European stock, any differences obtained tend to be rather small, inconsistent in direction and difficult to interpret. If lower scores are obtained from testing a relatively unsophisticated population e.g. Alaskan Indians, Aleuts and Eskimos (Eells, 1933), it is difficult to estimate how much should be allowed for "cognitive" difficulties, i.e. unfamiliarity with the testing situation, difficulty in following the instructions etc.

Several investigations have produced some evidence that Negroes tend to make higher scores in certain rhythm tests. The study of Van Alstyne and Osborne (1937) suggested that Negro children appeared to be markedly better in motor rhythm, the superiority being greatest for the simplest rhythms and the youngest subjects. On the whole, Negro populations tend to make their best showing, if tested with the Seashore Measures, on the rhythm test (Lenoire, 1925; Johnson, 1928; Peterson and Lanier, 1929) and to equal or excel the norms for white people. Streep(1931) using the K-D tests, compared over 1,300 white and Negro children and found the Negroes earned higher scores in rhythm. Robinson and Holmes (1932) found Negroes were excelled by white Americans, but in the case of the K-D rhythm test, by only a small amount. However, Johnson (1928) concluded from his study of 3,350 Negroes "that there are no significant differences between whites and Negroes on those basic musical sensibilities measured by the Seashore tests". Drake (1957) found no statistically significant difference between 17 Indian, 135 Negro and 308 white subjects when tested with his rhythm test. The Musical Memory score of Negro and white high school students showed no consistent or statistically significant differences (Drake, 1957).

Drake (private communication) has made especially careful efforts to test primitive and rural subjects where exposure to Western music would be at a minimum. This must have been particularly difficult in the case of his rhythm test since any music with a steady beat would be relevant. His claim that both the opportunity for training and for hearing Western music is at least less than for most white people sounds reasonable. He was able to collect data on Seminole Indians in Florida, Indians on Guam, natives of the Dutch Antilles, rural Mexicans and a small group of Japanese. "Although there is some variability, it seems to be due mostly to error of measurement rather than to any deficiency in any racial or ethnic group. The results are remarkable in that no real differences appear. This argues that the tests are relatively culture-free and that training has little effect on the test scores".

On the other hand, the scores of Oriental subjects tested by Farnsworth (1931) with the Seashore tests and with the Kwalwasser Melody and Harmony tests showed decreases from

American standards in inverse relation to the length of time the Oriental had lived in contact with Western music. At least in the case of the Orientals tested by Farnsworth himself at Stanford, the lower scores did not appear to be due to a lack of confidence or of willingness to co-operate or of misunderstanding the instructions. The differences, however, were not very large.

Wing (1936, 1948) found little difference between the average scores made by English subjects and those of Welsh, Jewish and German subjects who are sometimes regarded as particularly musical. Wing (1936, p.94) did find that the 41 German children, aged 12 to 13, he was able to compared with 101 English children appeared to "do the aesthetic type of test better than the English" (by, at most, 2 points out of 10). "Possibly this is due to the greater amount of first-rate music that the Berlin child can hear ... another reason might be that so many of the great composers have been Germans, a fact which appeals to their national pride and encourages them to listen more to the work of their own nationals".

Both Sanderson (1933) and Witherson (1935) found Jewish children did make rather higher average scores on the K-D tests than some other national and racial groups. Sward (1933) however, employing the more valid Drake Memory test, as well as Seashore and K-D tests, came to the conclusion that 200 Jewish children were only "slightly superior" to non-Jewish subjects. He contrasted this very small difference in talent with the very much greater achievement of Jews in music. About 50% of violinists in American symphony orchestras were of Jewish origin. Between 25% to 30% of piano virtuosi and symphonic and amusement instrumentalists were Jewish. Ten percent of American composers were of Jewish extraction. If the proportion of the highly talented is in fact no higher among Jews (in this connection comparison of the upper quartiles and not of the averages would be important), this would serve to show how much talent must exist unexpressed among non-Jews. Some of the Jews may have only achieved their professional positions at the cost of an undesirable amount of family pressure, which many Gentiles might find intolerable.

Special Groups - The Blind

Because they depend so much more on hearing than do sighted persons, the blind might be thought to have acquired useful experience in dealing with auditory and musical stimuli.

However, Seashore and Ling (1918) tested 15 blind students and compared them with 15 high school students and came to the conclusion that "The blind and the seeing are, on the whole, equally sensitive to the direction and intensity of sound." The same was true of pitch. Kwalwasser (1955) tested 100 blind children with the eight K-D tests which do not require the use of notation. Compared with the seeing, the blind were only average in pitch discrimination, intensity and tonal movement. Their scores for tonal memory, quality, time and rhythm discrimination were somewhat better than average. Sakurabayaski, Sato and Uehara (1956) administered the Seashore Measures to 282 non-music students, to 148 music students and to 150 blind non-music students and to 17 blind students of music. The music students scored better than the non-music students, but no clear difference between the sighted and the blind was found.

Drake (private communication) tested the entire population of a blind academy and found the average score for Musical Memory was very superior to his norms for sighted subjects. It would seem understandable that the blind should be superior in Musical Memory rather than Pitch Discrimination considering their long experience of dealing with (and remembering) meaningful stimuli perceived in succession. However, interim results of Pitman's research with 76 blind children aged 8 to 11 suggest their Wing scores are significantly superior only on tests 1 and 2. Heim (cited Wing 1963) tested 155 blind Americans, of whom 115 were over 17, with the Wing tests. The distributions he obtained were very close to Wing's English norms in grades A, B and C but slightly lower in D and E grades. It would be interesting to have further information on the musical experienc of blind subjects. Pitman's subjects from one school where much time was devoted to music did not seem to score better than pupils at another where music did not receive special attention.

Conclusions

No one is likely to disagree that some of the improvements discussed in this Chapter are of a purely "cognitive" nature, e.g. explanation of what is involved in the concept of pitch may help unsophisticated subjects to judge whether a second tone is higher or lower than the first.

But, in addition, there is evidence that a prolonged and efficient programme of aural training can raise the performance of certain prerequisite skills to a higher level. This might lead to higher scores on musical ability tests. It would seem legitimate to speak of an improvement in musical ability in such cases. How far-reaching the effects of such a change could become under optimum conditions is not known. This evidence does not deny the practical educational usefulness of diagnostic tests in selecting able children for special musical training or indicating which children are unlikely to progress far in music without exceptional efforts on the part of themselves or of their teachers.

CHAPTER IX

PRESENT INVESTIGATION - PARENTS AND CHILDREN

The aim of the first part of the present investigation was to compare the musical ability of a sample of parents and children, to see what connections existed which might be related to hereditary and/or environmental factors. Information on the latter was obtained by questionnaires.

The Tests Used

The Wing Standardised Tests of Musical Intelligence were used as the measure of musical ability. The disc version was administered as a group test, the number of items in the last four sub-tests (see Appendix I) being reduced from 20 to 14, as is the current practice. The subjects were also asked to fill in questionnaires. As can be seen from Appendix IIa and b, the first part of the form consisted of questions designed to assess the amount, if any, of instrumental playing, music lessons, concert-going and listening to music in the home. The second part consisted of 12 musical knowledge questions. As the same questions were to be used for both children and parents, they were intended to require general knowledge of music and composers, rather than knowledge of notation or the theory of music.

The Subjects

54 pupils of a mixed grammar school and 13 from a grammar

school for girls, both in the Home Counties, and 78 of their parents, were tested. The children included 14 siblings. Both parents attended the meeting in 25 cases. It is assumed that none of the children was adopted, the purpose of the investigation having been made clear to the parents beforehand. In the case of the girls' school, the parents were contacted largely through the efforts of the Music Mistress. Here the girls were more interested in music than their parents - 8 out of 13 stated they were very interested, while only 2 out of the 15 parents professed to be very interested in music. The parents whose children were attending the mixed school were contacted more directly. Only 2 out of the 63 parents, but 9 out of the 54 children, stated that they were indifferent to music, while 31 parents, but only 11 children, claimed to be very interested. The lesser degree of interest among the children at the mixed school may be partly due to a higher proportion of the boys being indifferent to music, since, by tradition, music tends to be regarded as a rather effeminate pursuit in all but the public schools for boys.

Treatment of Results: Age Adjustments and Scoring Procedure

The children's ages ranged from 11 years 1 month to 18 years 1 month (one elder sister, aged 21, was also included).

Before the children's Wing scores could be compared with their parents', an adjustment for age was necessary. Two methods were adopted. Where only a total for the whole battery was required, the raw scores were converted into Musical Quotients (MQs) by the use of Wing's formula (Wing, 1960). But it was also desired to consider the tests of ear acuity and memory (1 to 3) separately from the four appreciatioı tests. For this purpose the raw scores were plotted against age. Since there seemed no good reason why parents of more musical older children should attend the meeting more frequently than those of younger children, the variations should be either random or show genuine trends. In fact a fairly marked increase with age was found. As the variations appeared to be fairly uniform at all ages, it seemed reasonable as a rough approximation to use the same corrections at all score levels. When the sum of the two adjusted scores was plotted against MQs, correspondence between the two was very close, except for a few highly musical younger children who were placed lower than by Wing's norms. (Most of the differences were on the lower, rather than the higher, side). The corrections possibly should have been larger for high, than low, scorers. The adjustments actually made involved adding up to 8 marks to the raw scores for tests 1 to 3 and up to 5 for tests 4 to 7 to bring the scores of the younger children up to the 16+/17+ level.

A similar correction was made to the Musical Knowledge scores. In this case the adjustments meant adding from ½ to 2 points to the scores of the younger children.

Any group questionnaire is liable to collect unreliable answers. However, it was thought that in the present instance the parents who took the trouble to attend the meeting would give reasonably accurate answers to questions 1 to 10 and that the children were old enough to understand what was required. It was hard to judge how literally the instruction to include only listening to the radio when not doing something else was taken. One woman wrote that she took great joy in music and listened all day whilst she was doing all the mundane household chores. Since, however, concentrating on the music is often so far from achieved, even by many concert-goers under ideal conditions, it seemed best to accept the replies as given. The amount of playing and instruments played claimed by the subjects seemed reasonably accurate, when checked against the replies of other members of the family. The amount of playing showed no relationship to length of time the instrument had been studied, to the type of instrument, to the age or to the sex of the child. There seemed to be some tendency for those who claimed to be very interested in music to spend a longer time playing. Possibly the decisive factors were competing spare-time interests and the demands of school homework.

Learning to play the piano was taken to be equivalent to learning an orchestral instrument, in its effect on the general musical development of the child. This seemed justifiable, as nearly every child who was learning instruments like the violin played in an orchestra (usually the school orchestra) and, therefore, had the opportunity of absorbing the harmonic effects of music and of becoming acquainted with a wider repertoire than is available for solo instruments other than the piano. The only instrument which 12 of the children played was the recorder. A further 5 who had given up other instruments now played only the recorder. It seemed fair to regard the value of the recorder in the musical education of the child as more limited both because of the smaller capacity of the instrument and its limited literature. Therefore, a weighting of 1:2 was applied to the recorder as compared with the piano and orchestral instruments and an upper limit fixed, so that even the child who claimed to play the recorder for 7 hours a week was allotted only 2 points. Any such weighting can be criticised as arbitrary, but it seemed to give fairly rational results in the present case. After weighting, the total amount of playing by each child was rated on a 5 point scale (0 to 4) separately from the total amount of music lessons. In reaching a total for music lessons, no difference was made between past and present lessons. The same weighting and 5 point scale was applied as for playing. Each child's final rating or "Musical Activity Score" was based on the combined rating for playing and music lessons.

A good proportion of the replies on listening to music was expressed in a definite number of hours per week or, in the case of concert-going, in times per year. Some subjective judgment was required, however, in dealing with such answers as "as often as possible" and "occasionally". Attending musical performances "as often as possible" was taken as 8 times per year and "occasionally" as twice a year. "Very frequent" listening to records or broadcasts was counted as five hours per week, as was "daily" or "most days". "Occasionally" or "a little" was counted as 1 hour in 3 weeks. Such phrases might have a different meaning for an adult than for a child of 12. However, it seemed best not to try to make any such fine distinctions. For all three cases, concerts, records and broadcasts, a similar weighting of 3 for classical, 2 for opera and ballet and 1 for other types of music was applied. However, in the case of radio and TV, the subjects were asked what style of music they chiefly listened to. Where the replies indicated that the listening was to jazz or popular music, an upper limit of 2 points was given, even for very frequent listening. Wing (1954) allows that dance music may possibly be an early stage in musical appreciation. But its low value in musical development seemed to justify some limit. It might well be questioned, in any case, if even an adolescent really listens attentively to popular music for twohours a day. It might be argued that a person is more likely to give undivided attention to records rather than a broadcast concert, but such a supposition seemed too unsupported to make any differential weighting between these two necessary. Concert-going was rated on a scale giving approximately equal numbers in eight classes (0 to 7). Listening to records and broadcasts combined were rated similarly to the concerts. A "Listening Score" for each child and each parent was obtained by adding the two ratings.

When the children's Listening and Musical Activity scores were plotted against age, no consistent variations with age were found and no adjustment for age was made to these scores.

Age	11+	12+	13+	14+	15+	16+	17+
Mean Listening Score	7.0	6.5	6.2	8.2	5.8	6.4	8.6
Mean Musical Activity Score	4.4	3.6	4.0	4.0	4.9	5.8	4.1

Distribution of Results

As can be seen from the distributions detailed in Appendix III and the table below, the numbers of parents and children in Grades A and B are much higher than the percentages obtained by Wing when standardising his tests.

Table XX. Distributions of Wing Scores

	Grade A (10%)	Grade B (20%)	Grade C (40%)	Grade D (20%)	Grade E (10%)	Total
Parents:						
No. of fathers	6	10	11	6	4	37
No. of mothers	9	11	13	6	2	41
Children:						
Boys. Age						
11	2	1				
12		1	1			
13	1	1	1	1		
14			1			
15	1		2	1	1	
16						
17+	2		1	2		
Totals	6	3	6	4	1	
				Total number of boys = 20		
Girls. Age						
11	3	1				
12	6	1	3			
13	8	1				
14	6		2	1		
15	3	1				
16	3		2			
17+	3		1	1	1	
Totals	32	4	8	2	1	
				Total number of girls= 47		

Although the desirability of including parents and children at all levels of musical ability was stressed to the schools beforehand, it was only to be expected that parents who were themselves musical, or had some interest in music, or who felt their children would show some talent, would be likely to attend. The music mistress at the girls' school took great care to try to persuade the parents of the less musical children to attend the meeting. Evidently, however, her influence was greatest on the more talented pupils (see further p.301 below). A grammar school population is in any case likely to yield a mean for musical ability above the average for unselected schools (Cf. Chapters VIII and XII).

An advantage of the high degree of musical ability of most of the present subjects is that at this higher level the Wing tests have most reliability and validity (Wing, 1960) as they were primarily intended to select musically able children. The results obtained with the present subjects were quite satisfactory, as far as could be judged. How good the tests would be on unselected adults might be another matter. Performance on cognitive tests is liable to decrease with age, especially among adults whose work requires little skill or intelligence (Vernon, 1960). This is certainly not shown for the music testing in this limited sample of parents. While the majority of the adults tested by Wing are likely to be students receiving tertiary education, they are not selected (except a few) from those interested or experienced in music.

The norms (Wing, 1948, p.71) do not seem to fall after 17 with age but the weaker subjects may well score nearer the chance mark and the stronger ones may be keen and so able to maintain their attention longer and tend to increase their scores somewhat. However, this is a matter which would need further research.

Discussion of Results

The results are discussed in the following pages under three headings:

1. Correlations of Children's Musical Quotients and other Variables;
2. Parent-Children and Sibling Correlations; and
3. Child's Index of General Musicalness compared with Parental Scores.

Correlations of Children's Musical Quotients and other Variables

The results of correlating the children's MQs with the other three variables were as follows:

MQ - Musical Knowledge	n. 67	r = .322
MQ - Listening Score	n. 67	r = .177
MQ - Musical Activity	n. 67	r = .654

The correlation of .322 between MQ - Musical Knowledge seems reasonable considering that the latter would be likely to reflect opportunities to learn about music, interest, and general ability, none of which is usually found to be very highly related to ability to perform the Wing tests.

The low correlation with the Listening Score seems to require some comment. Inspection of the scattergram showed that the lower listening scores were generally associated with lower levels of MQ. This might be particularly expected with grammar schoolchildren, as the pressure of school work and the wide variety of interests available to them, might lead them to neglect music, if they lacked any high degree of talent. On the other hand, there was less agreement at the higher levels of ability, perhaps because talent is not necessarily accompanied by interest, or because the highly talented tend to devote the available time for music to playing or practising rather than listening. The scores of five individuals in particular showed considerable disagreement for the two variables. One girl whose MQ was only 69 owed her high listening score to the large amount of time she devoted to opera. The attraction of opera to a 14 year old girl is likely to be based on its emotional or dramatic, rather than musical, appeal. A second girl, with a MQ of 81 did hear a good deal of classical music and claimed to attend 4 or 5 concerts a year, possibly following the example of her more musical mother. A third had a high listening score (mainly classical and ballet music) and a score of 11 out of 12 on the Musical Knowledge questions. Though below the average of this very musically select group, her MQ was in fact 122. On the side of high MQ contrasted with below average listening scores was the most musical child (aged 13:6) in the whole group (MQ 221). Her relatively low listening score was due to most of her listening being devoted to jazz and popular music. She apparently heard less classical music than her parents (who, however, also seemed to like popular music). Another child with an MQ of 194 heard little music at home. This may have been due to her being rather young, at 12:10, for independent listening and to her parents not setting an example. Her mother reported that, though very interested, she had little time to listen. Had these five individuals been omitted, the correlation would have risen, but not so much as to suggest that performance of the Wing tests is unduly influenced by the amount of music the child listens to at home.

The high correlation between musical activity and MQ raises the question as to how far the Wing tests are influenced by instrumental training or vice versa. Wing's views have already been discussed in Chapters I and VIII above. It certainly seems likely that the parents of the children tested in the present investigation would have been sufficiently interested in providing lessons and encouraging any talent their children showed. As grammar school children, they were particularly liable to be forced to give up music lessons in face of the pressure of school examinations, unless their progress at music was very good. It is, of course, not only the untalented who are sometimes forced to give up playing - even John Ogden is reported to have nearly had to give up music when studying for his School Certificate.

It cannot be claimed that the present data contribute much evidence on the issues discussed in Chapter VIII. Most of the agreement between the scores was found among the 8 children who had never received music lessons, from the 9 whose musical activity score was 1 and from the 5 with the highest activity score (9). The data do not, however, show how far the below average Wing scores for the first two groups are due to a lack of musical instruction or, conversely, how far the fact that they had little or no opportunity of lessons was due to their not having shown any sign of talent for music. Though below average for the whole group, their MQs did range from 60 to 130. A boy with an MQ of 94 who had never learned music and was not interested could be contrasted with his sister who had, in the past, had 4 years of piano lessons and 2½ years of violin lessons (though she now played only the mouth organ); her MQ was 137. On the other hand, a girl who had received no lessons had an MQ of 107, while her brother, after 6 years of instruction on the violin up to 2 years before he was tested, had an MQ of only 81. In this case the amount of listening to music was very similar; the brother was interested, while his sister was indifferent to music. The MQ of another girl was only 95 though she had had piano lessons for 6 years and practised 2 or 3 hours per week. Her activity score was in fact the same as that of the highest scorer (MQ 221).

There was certainly some tendency for the older less musical children to give up music lessons. The more talented, usually younger, who for some reason had stopped having lessons on the piano or stringed instruments did appear to be trying to keep up their playing or some form of musical activity, if only the recorder class. But it is not suggested that their higher Wing scores were likely to be due to this.

No more definite conclusions can be drawn from the present data than that the rather high correlation of MQ and the musical activity score does not disprove the evidence of Wing and of Newton (see Chapters I and VIII) that the Wing tests are not unduly influenced by previous musical training. It seems fair to assume that reasonably intelligent children of grammar school age are not likely to continue with musical activity unless they find themselves at least moderately competent at it.

Parent-Children and Sibling Correlations

The following table lists the correlations found between the parents' and children's scores.

Table XXI. Parent-Children Correlations

Each parent with each child n. 100		
Wing - full battery		.290
Wing tests 1-3		.157
Wing tests 4-7		.260
Musical Knowledge scores: Parent-Child		.185
Listening scores: Parent-Child		.369
Parent's Listening score - Child Wing 1-3		.261
" " " " " 4-7		.312
Each parent with each child - Mixed school only n. 80		
Wing - full battery		.364
Both parents and children		
Father-Child Wing tests	n.25	.627
Mother-Child " "	n.25	.258
Father+Mother-Child* Wing tests	n.25	.475
Father-Son Wing tests	n.15	.678
Mother-Daughter " "	n.39	-.009
Father-Mother " "	n.25	.331
Higher scoring parent-Child Wing tests	n.25	.394
Siblings " "	n.14	.496
Father-Child Listening score	n.33	.412
Mother-Child " "	n.33	.510
Father's Musical Knowledge Score-Child's M.Q	n.33	.063
Mother's Musical Knowledge Score-Child's MQ	n.33	.096
Father's Listening Score-Child's MQ	n.33	.500
Mother's Listening Score-Child's MQ	n.33	.534

*Parents' scores averaged; in the 8 cases of siblings, the average of both children taken.

In so far as the Wing tests can be considered unaffected by the musical environment (see Chapters I and VIII), the correlations between the parents' and childrens' scores provide evidence of the extent of the innateness of musical ability. The question arises as to which of the various coefficients listed above are the most valid.

The highest correlation involving both fathers and mothers, the mid-parent-child, has the advantage of taking account of both parents, though the number of families is only 25. This correlation, .475, and the .496 for the siblings, are close to the .50 commonly reported between parents and children and between siblings in the case of intelligence tests (see e.g. Vernon, 1960)*.

Even the lower correlations found when each parent was compared with each child may be somewhat more favourable to the hereditarian side when at least the first of the following considerations is taken into account:

1. The musical ability of the present subjects is appreciably above average (see p293 above). This is particularly true of the children tested at the girls' school. Their median MQ was 153.3 and their parents' 100 as compared with 135.0 for the mixed school children and the 110.6 of their parents. From any such group highly selected from the top of the scale depressed correlations are likely to be obtained. For example, a correlation of only .27 (.08 with age partialled out) was found for Stanford-Binèt scores by Hildreth (1925)

*Intelligence is here used as some basis of comparison, but it might be unwise to pursue the parallel between a relatively specific ability, such as for music, and general mental efficiency too far.

among a group of 325 siblings containing a disproportionate number of bright children. In the present instance, when the parents and children from the girls' school are excluded, the correlation rises from .290 to .364. Since even the subjects at the mixed school were quite highly selected musically, this at least suggests that with a more representative sample of parents and children the correlation would rise rather than fall.

2. The effects of assortative mating and of dominance. As explained in Chapter VI, like marrying like tends to reduce regression towards the mean (and hence to increase resemblance between parents and children), while dominant traits show increased regression towards the mean (and therefore lower correlations are obtained between parents and offspring). In the present sample, no high degree of similarity was found between the Wing scores of the husbands and wives when they were both tested. Cattell (1950, p.340) mentioned that the correlations found with engaged and with married couples range from about .3 to .7 for such traits as weight, height, health (even degree of hearing acuity!), intelligence, and measured attitudes and interests. The present coefficient, .331, would come low in such a range. It is hard to know whether a similar correlation for musical ability would be obtained with other populations. Professional musicians often intermarry. Amateurs who devote a high proportion of their spare time to music might stand a higher than normal

chance of meeting, becoming interested in and marrying, other amateurs. But, for most people, similarity of degree of musical ability might seem a relatively unimportant factor in the choice of their marriage partner.

Certain previous studies mentioned in Chapter VII suggested that some degree of dominance might be involved in the transmission of musical capacity. The correlation between the more musical parent and child in the present investigation did not confirm any such tendency, but with such a small number the results could hardly be claimed as more than indicative.

It would seem unsafe to claim more than that the present correlations have not been unduly raised by assortative mating or lowered by the effects of dominance.

As can be seen from Fig. 1 Appendix IV the general agreement of father with child on the Wing tests is rather higher than the correlation indicates. The correlation is depressed by three children; if these were omitted it would rise to .814. The low Wing score of the father of child 25 may fail to do justice to his real ability, since he both played the violin and was a student opera singer. Apart from tests 1 and 5, which involve harmony, his score was reasonably good. (He was the only one of the fathers whose Wing score showed inconsistency with what could be deducted from the questionnaire data about their musical achievements). The other two of the three children whose scores deviate from their fathers' might possibly be considered "sports" i.e. children who resemble an earlier ancestor more than their father or mother.

A high measure of agreement between the parent and child of like sex might be considered to favour environmental theories. The father-son correlation is in fact somewhat higher than father with child of either sex. But the difference is not great and it might seem doubtful whether a father's influence on his son would necessarily be more powerful than his influence on an adolescent daughter in the case of a subject like music.

The high father-child correlation might argue more strongly in favour of the importance of hereditary factors, had the children been much younger and therefore spending much more time with their mothers than with their fathers. Older children might be more inclined to look up to their fathers and to seek to emulate his tastes and achievements. As far as could be assessed from the questionnaire evidence, any such supposition did not appear to be true in the present instance because

a) Little effect of a differential influence of playing an instrument by the father, as compared with the mother, could be discovered;

b) the correlation of the children's MQ with their fathers' Musical Knowledge scores was very slightly lower than with their mothers'; and

c) the correlations of the mothers' listening score both with the children's listening scores and with their MQ were rather higher than the fathers'.

Table XXII shows the amount of present playing and of music lessons according to the questionnaire answers given by the fathers and by the mothers of the 33 children classified according to their MQs into top, middle and bottom thirds. The connection between the MQ level of the child and the playing of either parent would appear to be negligible. The association with parental lessons seems to be somewhat greater but, for the present small numbers, not significant; it shows little difference in significance between the parents. (A somewhat different result was obtained with the larger group described in the next section).

Table XXII. Comparisons of Children's MQ Level with each Parents' Musical Activity

	Children (grouped according to MQ)			
	Top	Middle	Bottom	Chi-squared
Present Playing				
Fathers: None, rarely, "a little"	7	7	11	
½ hr. or more per week	4	4	0	
Mothers: None, rarely, "a little"	7	9	8	
½ hr. or more per week	4	2	3	
Music Lessons				
Fathers:				
None	2	6	8	7.15
Less than 5 yrs.	2	1	2	df 4
5 yrs. or more	7	4	1	p =.20 to .10
	11	11	11	

(continued)

	Children (grouped according to MQ) Top	Middle	Bottom	Chi-squared
Mothers:				
None	3	5	0	7.24
Less than 5 yrs.	3	2	6	df 4
5 yrs. or more	5	4	5	p = .20 to .10
	11	11	11	

The higher correlations with the mothers' listening scores suggest that even for these older children the mother, rather than the father, sets the environment. If one parent more than the other decided whether the child should have music lessons or what music should be heard in the home, one might have expected the parent with the more dominant personality or with the stronger interest in music to set the musical tone of the home. In fact, the parents tested showed quite close agreement in their degree of interest and listening habits. Both parents claimed to be equally interested in 18 cases, in 3 cases the father was more interested than the mother, while in 4 cases the mother was more interested in music than her husband. Some of the agreement between the parents may have been merely due to one parent accompanying the other (or the rest of the family) to a concert without feeling much interest in the music, or to hearing records or broadcasts because some other member of the family wished to listen. However, if question 7 of the questionnaire was answered with strict accuracy music heard only because some other member of the family happened to be listening, should not have been included.

The high father-child correlation would not appear, then, to be explicable by the evidence available on the children's musical environment. It is, however, difficult to understand how any sex-linked mechanism could be involved in the transmission of musical aptitude when boys and girls make approximately equal scores on the Wing and other music ability tests, (see Chapter VIII). If the gene concerned with musical aptitude were totally linked with the Y chromosome, it could only be passed on from father to son, never from father to daughter. If it were transmitted on the X chromosome and recessive, the sons would not be affected unless their mothers carried a similar gene, while the daughters would be carriers (but not show musical ability themselves). If it were totally X-linked and dominant the daughters, but not the sons, would inherit the musicality from their fathers. The inheritance of musical capacity is no doubt exceedingly complex and likely to involve many genetic factors, among which some partial sex-linkage might play some part. In the case of the two previous studies reporting somewhat closer resemblances between father and child than between mother and child (Haecker and Ziehen, 1922) and between brothers than between sisters (Swift, 1939), it was rather difficult to separate the effects of opportunity and training (see Chapter VII above).

Due to the small numbers, sampling errors and some selection effects might have contributed to produce the higher father-child, as compared with mother-child, correlation The mean listening score for the fathers was slightly higher than the mothers' (6.15 compared with 6.06). Women in general might be expected to listen to music more than men do. Wing observed (1941a, p.462) that women form the greater percentage of concert audiences. The fathers who volunteered to be tested might have been more motivated by a specific interest in music while their wives attended the meeting for more general reasons - an interest in the child's musical ability, as a change from home, to keep her husband company etc. Conceivably also, fathers, rather than mothers, might tend to be willing to be tested if they thought their child resembled themselves, either in being musical or unmusical.

This kind of selection effect, however, could hardly account for a zero correlation between mother and daughter. Part of the explanation at least might be found in the very high median MQ of the daughters: 151.4 compared with 105, the median of their mothers. The mothers included five individuals with MQs of 150 or over. Twenty one of the daughters had MQs of 150 or over. These very high levels are particularly liable to be affected by regression towards the mean. The regression lines inserted on Fig. 2 Appendix IV show regression of one half towards Wing's mean. (As mentioned above p. 186, there is some evidence that one half is about the regression to be expected in the case of both height and intelligence). The divergence of some of the scores is, however, much greater, especially for highly talented girls with below average mothers. The mothers, of course, may well have been at a disadvantage since they would almost certainly be less accustomed to any kind of test than their daughters.

In contrast, the median of the sons was 103, compared with 97.5 for their fathers. Only 2 boys (13%) were on the negative side of the scattergram. None of the fathers had a MQ of over 140, and only 2 sons had an MQ of 140 or over (both correlated well with their fathers' scores). On Fig. 1 Appendix IV where the daughters have been included as well as the sons when both parents were tested, the higher scores with one exception, as well as the lower, show close agreement with the fathers' scores. It might be unwise to conclude, therefore, that the high father-child correlation is due largely to the scores being closer to the average than for the mothers and daughters, before further research can verify or disprove the sex difference.

The correlation of .4 6 obtained by comparing the MQs of the older with the younger siblings is, as mentioned on p.301 close to the correlation "typically" obtained with siblings on intelligence tests.

The following intra-pair differences in MQ were found:

a) for 7 unlike sexed siblings - 10, 14, 16, 26, 43, 50 and 57.

b) for 7 like sexed siblings (all sisters) - 1, 1, 5, 33, 47, 48 and 59.

Thus, the large differences in MQ of over 40 points were found as frequently among the siblings of unlike sex as among the sisters. The two out of the three pairs of sisters whose MQs were so widely differing were separated, by considerable differences of age. On the whole, however, the extent of MQ differences did not appear to be consistently related to age. From the present small number of siblings, it was not possible to discover whether there was any consistent connection between differences of MQ and environmental differences. The less talented sibling was sometimes the more musically experienced (Cf. p. 299).

The correlation between the parents' and childrens' Musical Knowledge scores appears to call for little comment. Considering that much of the child's knowledge about music is acquired outside the home, a low correlation was to be expected.

The moderate correlation between the listening scores of parents and children in the larger sample seems reasonable and would reflect the tendency of the child to accompany the parents to concerts and to listen to the same music in the home. The extent of the agreement did not appear to be related to the age of the children. Appreciably higher correlations for listening scores were found where both parents were tested (though the correlations with Musical

Knowledge were zero). That both parents should volunteer to be tested might mean that in their homes music is regarded as an activity in which all the family takes part. The actual amount of listening, as measured by the mean listening scores, was, however, very similar to that of the larger sample. The children of the latter, in fact, had a slightly higher mean listening score.

In the cases of the children both of whose parents were tested, the correlation between their Wing scores and their parents' listening scores is quite high. From the low correlation (see p. 296) of the children's own listening scores and their Wing results, their <u>current</u> listening did not appear to have much effect on their ability to do the Wing tests. This, however, might not disprove that growing up in a home where good music is listened to frequently might improve performance at the tests. (The adults' listening scores might reflect their listening habits in the past as well as in the present more than the children's would). But this point will be dealt with further in the next section.

Child's Index of General Musicalness and Parental Scores

An index of the overall musicalness of each child was obtained by adding the Wing scores, corrected for age, to the sum of the scores for Musical Knowledge, Activity and Listening. Equal weighting was given to the Wing scores and the total of the other three variables by multiplying the former by $\frac{5}{13}$ (the SDs were approximately 13 and 5 respectively). On this basis, the children were then divided into 3 groups: (A) the 22 most musical with a range of overall score of 79 down to 56, (B) the 22 medium with a range from 55½ to 45½, and (C) the 22 least musical whose indices ranged from 45 down to 34. The parental scores for Wing tests 1-3, 4-7 and for Musical Knowledge were averaged for the three groups. A detailed analysis of each distinct item from the questionnaire was made and tabulated against the groups in order to see which factor would show the closest connection with the child's General Musical level.

The following table shows the average Wing and Musical Knowledge scores for the parents of the three groups.

Table XXIII. Parents' Wing and Musical Knowledge Scores compared with Children's Musical Level

Children	No. of parents	Parents Average Scores Wing 1-3	Wing 4-7	Wing 1-7	M.K.
Top	36	51.28	32.47	83.75	7.62
Middle	31	51.84	32.32	84.16	7.61
Bottom	32	46.28	28.34	74.62	7.48

Children		Fathers Wing 1-7		Mothers Wing 1-7
Top	n. 17	86.35	n. 19	81.42
Middle	n. 12	80.67	n. 19	86.26
Bottom	n. 18	72.94	n. 14	76.80

When both parents' scores are considered together, there is little difference between the top and middle groups. But when the Wing scores are taken separately for each parent, the fathers' averages fall consistently with the children, while the mothers' are higher for the middle than top group. This might have been expected from the high correlation between father and child on the Wing tests (see above). (It should be noted that if the children had been classified by Musical Quotient instead of by an index of musicalness, only very few children would have been placed into a different group and the differences in results would have been slight).

When only one of the parents attended the meeting, he or she was asked to answer questions 1 to 8 on the questionnaire on behalf of the absent spouse as well as his or her own.

These data were included in the analyses shown in Table XXIV, thus bringing up the number of parents to 120, 60 fathers and 60 mothers. The classifications adopted were those which appeared to give a reasonable fit with the data. It seemed desirable to consider attendance at concerts of "classical" music and listening to records of this type of music separately from opera, ballet and "other" music. There were not sufficient numbers involved to make a division between opera and ballet on the one hand and the other kinds of music on the other worth-while. Listening to opera and ballet on the radio or TV was not mentioned frequently enough to treat them separately. They were, in this case, added to the "good" or "classical" music class. Music called "light classical" by the subjects was divided equally between the "classical" and the grouping which included light and popular music. No distinction was made between frequent and very frequent listeners to light and popular music. The numbers concerned were rather small and it was assumed that the value of listening to that type of music might be limited in its effect on the musical development of the listener.

The general picture which emerges from Table XXIV is that of the parents of the bottom group of children being rather considerably less active as regards playing, concert-going and listening to music, than those of the other two groups. Out of the 40 parents of this group, only 3 now play when the child is at home, 22 never had music lessons,

Table XXIV. Childrens' Musical Level Compared with Parental Attitude, Activity and Listening

Parents	Children Top	Children Middle	Children Bottom	Chi Squared	P
General Attitude					
Very interested	22	16	11	4.90	.10to.05
Interested	18)	22)	26)		
Indifferent	0) 18	2) 24	3) 29	df 2	
	40	40	40		
Present Playing					
None, rarely, "a little"	26	27	37	9.867	.01
½,1,or more hours per week	14	13	3	df 2	
	40	40	40		
Past Playing					
None, rarely, "a little"	22	27	32	5.716	.10to.05
½,1,or more hours per week	18	13	8	df 2	
	40	40	40		
Music Lessons					
None	10	7	22	18.615	.001
Less than 5 yrs.	11	20	10		
5 yrs. or more	19	13	8	df 4	
	40	40	40		
Concert Attendance (classical)					
Never, rarely	14	18	23	3 categories χ^2=6.737 df 4	.20to.10
1 or 2 a year, "Occasionally"	15)	14)	14)		
	)26	)32	)17		
More than 2 a year	11)	18)	3)	2 categories χ^2=2.73 df 2	.30to.20
	40	40	40		

(continued)

Parents	Children Top	Middle	Bottom	Chi Squared	P
Concerts (other)					
Never, rarely, less than 1 a year	17	19	25	3.442	.20 to .10
1 a year or more	23	21	15	df 2	
Records (classical)					
None, rarely	14	20	24	3 categories χ^2=12.008 df 4	.02 to .01
1 hour a week or less	14))26	11))20	15))16	2 categories	
More than 1 hour a week	) 12)	) 9)	) 1)	χ^2=5.03 df 2	.10 to .05
Records (other)					
Never or less than ½ hr. per week	27	23	31	3.643	.20 & .10
½ hour or more per week	13	17	9	df 2	
Radio					
"Good" music, very freq. (2 hrs. or more per week)	12	7	8	12.45	Almost
"Good" music, frequently	10	17.5	10	df 6	.05
Light music, jazz, freq. or v. freq.	9	10.5	6		
Infrequent listeners (less than ½ an hour)	9	5	16		

23 never or rarely go to concerts, 24 never or rarely listen to records of classical music and 16 do not listen to music of any kind for even half-an-hour per week. The only categories in which more of bottom group's parents made a more favourable score than those of the middle group were listening to classical records for an hour or less and in very frequent listening to broadcast classical music.

In the cases of some of the variables such as attendance at concerts of classical music more than twice a year and listening to classical records, numbers fell from the top through the middle to the bottom group. On the other hand, nearly as many of the middle group's parents play and more have had music lessons than those in the top group. There is perhaps an indication of a qualitative difference between the top and middle group parents - while almost twice as many of the latter have had up to 5 years of instruction, fewer have had 5 years or more of lessons; nearly as many attend concerts once or twice a year, fewer go more than twice a year; more listen frequently to classical music on the radio or TV and more listen to other types of music ("light" music was mentioned by several subjects in this group as the style of music most often heard) but fewer listen very frequently to good music.

On the whole this analysis illustrates the tendency of a high level of musical ability to be associated with active participation in musical activities and with the appreciation of good music. The difference between the groups, as tested by Chi-squared, were more significant for some of the variables than for others. Only in the case of present playing by the parents and in the case of the parents having had music lessons does the probability reach the .01 level. The statistical significance of listening to records of classical music depends on the classification adopted. If listening for an hour or less is combined with listening for more than an hour, then χ^2 falls to 5.03 and P to between .10 and .05. The extreme drop in the number of listeners for more than 1 hour among the parents of the bottom group of children seems in keeping with the trend shown in the other variables. Therefore, though the F^e falls to 7.3, it seems reasonable to separate these two classes.

Generally speaking, the active participation of parents either in the past or present, seems to be more associated with the child's musicalness than "passive" listening. Within the listening group of factors, home listening as opposed to concert-going seems more important. This may be partly due to the subjects living at a fair distance from the London concert halls, at least from the point of view of the parents of younger children. As might be expected, listening to classical music either at home or outside seems more important than listening to other types. (The children's listening scores were, of course, weighted in favour of classical music and the Wing tests are based on musical material composed in classical style).

The connection between parents playing and having had lessons and their children's musical level can be interpreted in several ways:

1. Some psychologists might argue, as does Wing (see Chapter VII above), that those parents who have had lessons and play to their children are themselves talented and the children are likely to have inherited their ability.

2. Others might favour a more environmentalist explanation and suppose that parents who have had lessons are much more likely to be willing a) to provide lessons (if a piano is already available in the home, the capital cost of providing an instrument is saved), b) to tolerate the child's practising, c) to encourage the child to persist and master the difficulties which even the most musical are bound to encounter.

3. If one or both parents play, the child is more likely to grow up feeling that music is as normal a part of life as reading and that playing an instrument is a skill he is expected to master.

4. The actual sound of the music being produced by the parent, and perhaps by friends of the parent, might be an important contribution to the child's musical environment.

While the fourth point might have had some significance before the days of recorded and broadcast music, it would seem less important nowadays. In fact only 4 of the parents included in the present investigation sang or played as much as 6 or 7 hours a week to their children (Question 2 asked the parents only how often they played when the child who was going to be tested was at home. Strictly speaking, therefore, they should not have included other playing e.g. in the local music society orchestra of which several were members).

Particularly in the early years of life, the example set by the parents in playing an instrument might seem more important in its influence than the music coming out of the TV or radio set. However, the parents' playing when the child was between the ages of 2 to 5 had evidently less significance than later playing. The fall in significance, statistically, is largely due to the larger number of bottom group, as opposed to top group, parents who had given up their playing in later years. The numbers who continued to play in the middle group has remained the same. The decreased significance of the past playing may be a sign of low parental talent or it may merely mean that the child is at home less often since reaching school-age or that the parents are now more free to take up activities outside their home than when the children were younger. It does not disprove the importance of the parents' contribution to the musical environment of the very young child.

Since, as far as the present evidence suggests, the fact that the parents have had music lessons is at least as important as their actual playing, points three and four are by no means an adequate explanation. The present or past playing would be affected qualitatively by the amount of lessons the parent had had. Possibly, however, the main effect of having had lessons would be to make the parent readier to afford the child facilities for instruction and to provide intelligent and sympathetic guidance. As Graves (1947) realised (see Chapter VIII), the wider relationship between parent and child, the parents' emotional adjustment etc. are to some extent involved in whether the child has music lessons. Some highly talented parents might even be too critical of the child's early efforts to learn and of the music teacher's methods, and might actually discourage the child. On the whole, however, the present evidence appears to confirm Grave's findings that it is of some importance that the child should feel his parents want him to take lessons and that <u>both</u> parents should have had lessons themselves. The proportion of cases where both parents had had music lessons was 12 to 18 for the top group, 11 to 17 for the middle and only 3 to 14 for the bottom group of children. In so far as the parents' general attitude may have significance, those who stated they were "very interested" in music presumably were anxious that their offspring should grow up enjoying music. Their attitude might have a long-term effect even if, at certain periods, the child did not appear particularly interested .

A difference between the parents' attitude to music, and the numbers who have learned music and who play would not seem, however, to account completely for the difference in ability between the three groups of children. In only one case among all the families represented in the more musical groups neither parent played nor had received musical instruction. In all but four families of the bottom group at least one parent played or had had lessons and, therefore, might be willing to encourage any aptitude the child might show. It seems unlikely that any of the children included in the present investigation would have lacked adequate parental encouragement to learn music.

The parents' own musical ability seemed to show, broadly speaking, a positive association with whether or not they had received musical instruction (see further p. 323 below). If a Wing score of 80 could be expected to include individuals more likely to benefit from music lessons, 35 of the parents with a Wing score of 80 or more had had lessons; only 2 with the higher scores had had no instruction in music. On the other hand, 16 of the 28 parents below Wing's mean score of 76 had never had lessons. Wing's supposition (see Chapter VIII) that the parents who play are those who have musical talent is thus broadly true of the present group. (This assumes that the subjects have had the opportunity of learning to play because they showed talent, and not that they were able to make high Wing scores because they had previous experience of learning an instrument). The children of the talented parents who have had lessons are to be found in the top group. As far as having lessons for a long period is confirmatory evidence of ability, nearly 50% of the parents of the top-group have had musical training for more than 5 years.

Since the children's Wing scores correlated much more highly with their fathers' than with their mothers', it seemed worthwhile to analyse the fathers' questionnaire answers separately from the mothers' at least for those factors where significant associations with the children's index of musicalness had been found when the parents' answers were combined.

Table XXV shows that the fathers' playing is slightly more associated with the children's musicalness than is the mothers'. But in neither case is a significant value reached. The relation of child's musicalness to parents' music lessons is very much higher in the case of the fathers than of the mothers. This is partly due to 15 out of 21 of the fathers of the bottom group never having had music lessons. This does not seem to have been caused by fathers of ability having less opportunity to learn than mothers; for of the 10 fathers whose musical ability was tested and who had not received lessons only 1 was in grade B. Three were in grade C and the other 6 were in D or E. Moreover, out of the 9 mothers who had enjoyed the opportunity of music lessons and whose Wing scores were obtained, only one was below grade C, 7 were above average, 2 of these being in grade B.

Table XXV. Comparison of Children's Musical Level with Fathers' and Mothers' usical Activity

	Children Top	Children Middle	Children Bottom	Chi-Squared
Present Playing:				
Fathers:				
None, rarely, "a little"	13	14	20	5.884
½,1 or more hrs. per week	7	5	1	df 2
	20	19	21	P = almost .0[illegible]
Mothers:				
None, rarely, "a little"	13	13	17	4.381
½,1 or more hrs. per week	7	8	2	df 2
	20	21	19	P = .20 to .10
Music Lessons:				
Fathers:				
None	4	4	15	20.646
Less than 5 years	7	12	3	df 4
5 years or more	9	3	3	P = .01
	20	19	21	
Mothers:				
None	6	3	7	4.915
Less than 5 years	4	8	7	df 4
5 years or more	10	10	5	P = .30 to .20
	20	21	19	

As an environmental factor, it is hard to see why the father having had lessons should be more closely associated with the childs' musicalness than the mothers having learned to play. It would seem more likely that inheritance of ability, especially apparently from father to child, is involved.

To sum up this section, while the present data show close agreement between ability and certain environmental factors, there would seem to be little ground for attributing the high scores made by many of the subjects to the results of superior training or opportunities for listening to good music. If the subjects could have been drawn from a population where a high proportion of the parents and children had had little opportunity to have lessons, more crucial results might have been obtained.

Conclusions

It would be hard to claim any real separation of innate from environmental factors from the evidence presented in this chapter. The parents were themselves rather above average in musical ability. The children were high in musical talent and had enjoyed greater than average opportunities to have music lessons and to listen to good music.

However, even from this musically select group, correlations of up to .475 were found between the children's Wing scores and those of their parents of both sexes. This seemed reasonable evidence of musical ability having an important innate aspect.

For the 25 cases where both parents had volunteered to be tested a much higher correlation was found between the fathers' Wing scores and their children's, than between the mothers' and the children's. The difference did not appear to be explicable on environmental grounds, as assessable from the questionnaire data. While it might have some genetic basis, it might be regarded as suggesting that for levels of ability representative of the average, a moderately high association may exist between the musical ability of parents and their offspring.

Of the environmental variables, learning to play an instrument, both on the part of the child and of the parent, appeared to be more closely related to the results of the Wing tests than interest in music, as evidenced by the amount of listening.

The educational implications of these results will be discussed in Chapter XIV.

CHAPTER X

PRESENT INVESTIGATION PART TWO: TWINS BROUGHT UP TOGETHER

The aim of this part of the investigation was to test and compare the musical ability of as many pairs of identical and non-identical twins as could reasonably be located.

Tests Employed

As for Part one of the investigation, the Wing Standardised Tests of Musical Intelligence were used, the disc version in the case of the earlier testings, the tape recording for the later ones. The subjects were asked to fill in a short questionnaire of 10 questions on music which attempted to cover some of the topics which might have been included in the school music lessons. The twins were also questioned by the writer individually, when possible, in order to discover how far they were treated alike by their parents and how far they differed from one another in interests or activities. When individual cross-examination was not possible with the larger numbers and older children at the two comprehensive schools visited, the answers were recorded on questionnaires.

Subjects

The twins came from two sources: a) from some 20 schools in London and the Home Counties where the writer tested 50 pairs and b) from the Maudsley Hospital where Mr. Shields kindly tested 11 pairs of young adults (see further p. 330 below).

The sample of children consisted of 20 identical twins, (10 pairs of boys and 10 pairs of girls), 21 fraternal twins of like sex (9 pairs of boys and 12 pairs of girls), and 9 pairs of unlike sexed twins. They were mostly located by writing to headteachers who might be likely to be interested in helping the investigation. The headteachers were asked if there were any twins over 10 years of age on the school register. The age of 10 was taken as the youngest age at which reasonably reliable results would be likely to be obtained by group testing unselected children. One pair of younger twins was actually included because they happened to be available at a school visited to test older children. It was found that most of the twins tested in Primary schools made low scores. Therefore, the writer tried to obtain older twins whose scores might be more likely to arise reasonably above the level of chance in the Wing tests (especially the last four tests). However, even among the Secondary school children many of the scores were low.

Most of the twins were not particularly interested in music, but they usually appeared to be doing their best, philosophically, if not enthusiastically. When testing one or two pairs of twins, the experimenter is naturally much more aware of signs of lack of concentration that would pass unnoticed in a large group. Even with very able adults or children undergoing any exacting examination or test, facial expressions may often appear to show doubt or dismay. When, however, some of the later Wing tests appeared to be beyond the capacity of the subjects, the more difficult last items of the tests 6 and 7 were omitted. The same had occasionally to be done owing to a shortage of time.

In her initial letter to the schools, the writer asked for the facility of "a quiet room" to do the testing. Except in two cases*, the rooms provided by the schools were free from distracting sounds, except of a transitory nature which were, it was thought, unlikely to have affected the test results. The tape recorders and record players used were reasonably satisfactory, if not always of the highest quality.

Criteria of Diagnosis as MZ or DZ

Clinical aids to differentiating the monozygotic (MZ) from the dizygotic twins (DZ) as described in Chapter VI above not being available, the writer had to rely mainly on a) general "Gestalt" impressions of likeness and b) careful analytical inspection with special attention to colour of eyes, of hair, size and shape of face, etc. Questioning the twins themselves proved helpful in clearing up some cases of doubt (Cf. Marshall, Hutchinson and Honisett, 1962). Some super-

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*In one of these cases, the results were discarded, in the other only the later tests seemed to have suffered. The scores for the first three tests were, therefore, used with the chance-score of 19 added to interpret the results according to Wing's norms (see further p.331 below).

ficially similar pairs vigorously denied that they were ever mistaken for one another by relatives or teachers.

The proportion of MZ to DZ twins in the present sample (40 : 60) is higher than the proportion in the population, (28 : 72) according to General Register Office statistics). The shortage of DZ pairs may partly be accounted for by lack of opposite sex pairs which should be as numerous as same-sexed DZ pairs if ascertainment were complete. Many boy-girl twins would be at different schools and likely to be missed. It is usually considered better to exclude opposite sex pairs in twin research, but nine pairs were included in the present investigation to help to increase the size of the sample. The shortage of DZ pairs is also partly due to the writer's deliberate attempt to obtain fairly equal numbers of each type. A few dissimilar twins may have been missed, because they were not known as twins to the school. However, this seems unlikely because the writer always received the impression that whoever was making the arrangements for the testing to take place appeared confident that all twins of suitable age had been included. The effect of overlooking dissimilar fraternal twins would in general be to underestimate the extent of hereditary control (Vandenberg, 1956).

Adult Twins

Through the kindness of Mr. Shields of the M.R.C. Psychiatric Genetics Research Unit, 11 pairs of adult twins were tested with the Wing tests and a Musical Knowledge questionnaire, and the results passed on to the writer. These twins formed part of a sample of twins drawn from L.C.C. schools for investigation at the Maudsley Hospital (see Blewett, 1954), whose cases were being followed up. Their ages ranged from 22:1 to 25:0.

As it was anticipated that they would be less well-informed about music than the parents who took part in the first part of the present investigation, a simplified version of the Musical Knowledge questionnaire was used (see Appendix V).

Treatment of Results

The writer considered it worth-while giving the full Wing battery, even in unpromising cases. Only musically able children can be expected to make better than chance scores in the last four tests before the age of 11. However, many of the older twins made less than the chance score of 19. Therefore, in order to partial out age, by the use of the Wing norms, the chance score of 19 was added to the total for the first three tests. This procedure, according to the opinion kindly expressed by Dr. Wing, would be likely to give a more accurate result. Such in fact proved to be the case, as far as could be judged from comparing the MQs so computed with those using the actual scores for tests 4 to 7 in every case. When the actual scores were used, much larger differences were nearly always produced within each pair, especially with the younger children. The median intra-pair difference for the MZ boys rose from 13 to 18, for the MZ girls from 10.5 to 14, from 11.0 to 19.5 for the DZ boys, etc. Usually, the increase in difference was due both to the score of the more unmusical twin falling and that of the less unmusical rising. One boy's MQ was reduced from 47 to 27, while his brother's was raised from 59 to 73. In three cases, however, the higher became the lower scorer. For example, a difference of 11 in favour of twin A was turned into a difference of 19 in favour of B. It seemed more likely that these changes might be due to a larger amount of guessing during testx 4 to 7, than to reliable differences in real ability. Therefore, in each case where the minimum score for tests 4 to 7 fell below 19 for either twin, the chance score of 19 was added to the twins' scores for tests 1 to 3, and the MQs calculated according to Wing's formula (Wing, 1960).

This procedure had to be adopted in 34 cases - 13 identical and 21 fraternal, including the three DZ twin adults. It could possibly be objected that a bias might thereby be introduced into the results of the intra-pair correlations by reducing the differences in one type more than in the other type of twin. It seemed, therefore, advisable also to calculate the MQs for all subjects using the minimum in each case. In the following pages these will be referred to as MQsII, to distinguish them from MQsI obtained when the actual scores were used, were 19 or over, for tests 4 to 7.

In most cases the within-pair differences were not greatly changed, less than would seem to be indicated by a comparison of the medians and means of the intra-pair differences for MQI and MQII (see p. 342).

As can be seen from the distributions (Appendix VI), the MQs for the most highly talented subjects were considerably reduced. This seemed an advantage, as extreme scores can unduly affect correlations when the sample is as small as in the present investigation (see further p.351 below). Many of the subjects whose scores for tests 4 to 7 exceeded 19 had MQs much below the average of Wing's norms. Their scores on the first three tests were probably a more reliable measure of their musical ability than when performance on the appreciation tests was also taken into account.

Before discussing the results of the intra-pair differences and correlations, it seems worth mentioning the results obtained from two pairs of twins who happened to be tested twice. One pair was first tested at the age of 10, with the disc version of the Wing tests, and on their own. Five years later they were tested with four other pairs of boys at their secondary school with the tape version of the test. The results obtained on the second occasion are similar in total, but distributed over the sub-tests in a different way:

	First Testing								Second Testing							
	Tests								Tests							
	1	2	3	4	5	6	7	Total	1	2	3	4	5	6	7	Total
Twin A	4	10	5	8	6	9	7	49	7	12	14	5	5	6	2	51
Twin B	6	10	3	6	9	6	7	47	5	12	9	4	3	8	6	47

Their performance at the last four tests was, on the first testing, comparatively good, though their memory for music appeared very weak. According to Wing's norms scores should increase with age by about 20 points between 10 and 15. Their MQs, therefore, drop from 75 and 68 to 55 and 47. The more recent figures were used for purposes of calculations. On the first occasion, twin A scored 4, twin B, 1, for Musical Knowledge; on the second, their scores were 3 and 5. Both now claimed to be interested in music and spent 10 or 11 hours a week listening to jazz and popular music. At 10, twin A described himself as very interested and twin B stated that he was indifferent. Though they usually stayed together when with other children and were not very different in their interests and hobbies, they were quite dissimilar in appearance and the writer had no hesitation in classifying them as dizygotic.

This result perhaps shows the necessity to follow up individuals as well as groups in studying reliability. In a group testing they would be low on both occasions and would therefore not greatly depress a test-retest correlation. One might explain their lack of improvement with age by supposing that, as with children of low intelligence, those who are unmusical tend to give up trying and become even weaker. Though they appeared to be trying on both occasions, they may at 10 have been more anxious to please by doing the tests as well as they could. Their apparent deterioration may not have been confined to music. The IQ of Twin A was 95 and that of his brother 92, according to the figures given to the writer by their Primary school. At the comprehensive school, however, they were apparently considered well below average in educational achievement. At the latter, all the pupils had at least one period of music included in their time-tables, so that they did not lack reasonable opportunity to develop any musical aptitude they might have possessed.

The second pair of twins who were tested twice were the daughters of a professional instrumentalist. On the first occasion they were tested in their own home with another pair of twins and a girl friend. They did not appear to be concentrating particularly well - the testing took place during the first few days of the summer holidays. They did not seem very interested in being tested. But, when the writer visited their school nearly a year later, they volunteered to take the test again, perhaps because they knew that they had done well the first time. On the second occasion the test took place in a large hall after school hours, with four other pairs of twins present, all of whom took the proceedings particularly seriously. On both occasions the tape version of the test was used. In spite of the superficial differences of "atmosphere" at the two testings, almost the same results were obtained. Allowing for the increase in age, the MQs of both showed a fall of 3 points. The close agreement between the two testings is indicative of the high reliability of the Wing tests with gifted children.

The details of their marks are as follows:

	First Testing Tests 1	2	3	4	5	6	7	Total	Second Testing Tests 1	2	3	4	5	6	7	Total
Twin A	5	28	17	5	7	9	7	78	5	27	23	4	10	6	6	81
Twin B	7	27	20	10	7	6	7	84	14	28	17	4	10	7	6	86

At 13, Twin A had a MQ of 136; at 14, her MQ was 133. Her sister's MQ on the first testing was 151, and 148 on the second.

Twin B was considered better than her sister in other subjects, either because of higher general ability or of a greater willingness to apply herself to school work, or probably both. Twin A sometimes gave the impression of not being very interested in anything except pony-riding. Both stated that they were interested in music. At the age of 14, Twin B had been having piano lessons for 6 years and Twin A for five.

They stated that they attended concerts only rarely (about twice a year) and went four times a year to the ballet, though they had accompanied their father to the Edinburgh Festival. The music they listened to at home was mostly "Pop", perhaps in confirmity with the tastes of their school friends. Since their father's instrument was the trumpet, he may not have played at home very often. Neither their mother nor any of her family claimed to be musical.

Intra-Pair Differences and Comparisons with other Variables

The remarks in this section apply to the intra-pair differences in MQI. Where necessary, any modifying comments in the light of the intra-pair differences in MQII have been added. When the intra-pair differences in MQII varied from those in MQI by more than a few points, the alternative figure has been noted in brackets.

The distributions of intra-pair differences for each class of twin were as follows:

Table XXVI. Distribution of Intra-Pair Differences

MQI									
MQ Points Difference	MZ				DZ				
	Children		Adults		Children			Adults	
	Boys	Girls	Men	Women	Boys	Girls	Mixed	Men	Women
0-4	3	2			1	1	1	1	
5-9	1	2	1	1	3	3	1		
10-14	3	2		1	2	1	1		
15-19		1	2	1		1	4		1
20-24	3	2			2		1		
25-29			1			3	1	1	
30-34		1			1	1			
35-39									
40-44			1						
Over 45						2			
Totals	10	10	5	3	9	12	9	2	1

(Continued

MQ Points Differ-ence	MQII								
	MZ				DZ				
	Children		Adults		Children			Adults	
	Boys	Girls	Men	Women	Boys	Girls	Mixed	Men	Women
0-4	4	2	2		1	3	1	1	
5-9	1	2		1		2	1		
10-14	2	2	2		3	2	2		
15-19		1	1	1	2	1	4		1
20-24	3	2		1	1				
25-29					2	2	1	1	
30-34		1				1			
35-39									
40-44									
Over 45						1			
Totals	10	10	5	3	9	12	9	2	1

The smaller differences are somewhat more frequent among the MZ twins and the larger among the DZ groups. The greatest difference, 33 points, to be found among the identical child twins came from a pair of girls, aged 12:3, whose MQs were 60 and 93. The twin who stated that she disliked music made the higher score; her sister wax merely indifferent. Neither played nor did anyone in their home play. One pair of male adult MZ twins had a difference of 41 points between their MQI. (The MQII difference was, however, only 15 points). Both described themselves as interested in music, but neither played. The twin with the higher music score (MQI = 116; MQII = 82) was consistently better than his brother on every test except the first. The less talented brother, however, scored higher than any other adult twin in Musical Knowledge

(11 out of 12).

The proportion of large differences is much less than among the siblings, described in Chapter IX, where differences of over 40 points were found in 6 out of 14 pairs. As was the case with a few of the siblings, some of the differences among the DZ twins were very small, even among those of unlike sex. Among two sets of girls a considerable difference was found. In one pair aged 16:1 the difference was 55 (25) points. Twin A, MQ 155 (108), had studied the violin and the piano for 9 months and for a year from the age of 13. Her sister, MQ 100 (83), stated that she had received three spells of music lessons: piano at 8 for one year, violin at 13 for 9 months and piano at 15 for 1 year. She also had formerly belong to a choir and a madrigal group. Twin B played the piano for about 2 hours a week, twin A for about 4 hours. Both marked "interested" as describing their attitude to music, but twin B, asked about some of the ways in which she differed from her twin, remarked that "I don't like music so much". Thus, the more talented twin, though she had received in all fewer lessons, seemed to be willing to spend more of her time practising (perhaps because she was more successful). A difference of 88 points separated the MQs of two girls aged 11:9. Both failed to write their answers in the right spaces for question 1 on the answer sheets. Both failed to score up to the level of chance on the last four tests. When their MQs were calculated taking their actual scores for the last four tests, a difference of 68 points was obtained. Their MQ is, therefore, based only on their performance of tests 2 and 3. As they were tested with ten other sets of twins in an ordinary sized class-room, it might be supposed that twin A copied some of her answers from a more talented companion. This seemed unlikely, as this pair of twins occupied front seats and could be particularly well invigilated. When her answer sheet was carefully compared with those of the other children tested at the same time, no evidence of any cheating was discovered. Twin B may have done herself less than justice, through feeling unwell or upset (Cf. Wing, 1962, p.45). Neither twin played. Their father played the piano, but they did not state how often. Their listening was mostly confined to popular music. The twin with the low MQ described herself as "very interested" in music, while her sister said that she was "interested".

The following means and medians of the intra-pair MQI and MQII differences were calculated for each type and sex of twin:

Table XXVII. Means and Medians of Intra-Pair Differences

MQ Points	MZ Children Boys	MZ Children Girls	MZ Adults Men	MZ Adults Women	DZ Children Boys	DZ Children Girls	DZ Children Mixed	DZ Adults
			MQI					
Means	12.00	12.90	21.6	11.7	13.89	25.83*	15.33	15.67
Medians	13.00	10.50	18.0	14.0	11.00	21.00	16.50	18.00
			MQII					
Means	10.90	13.10	9.20	15.67	16.33	20.04*	13.67	15.67
Medians	9.00	12.00	11.00	15.00	15.00	12.50	15.00	18.00

*would fall to 20.18 and 13.86 respectively if the pair with the difference of 88 points were excluded.

On the whole, the MZ/DZ contrast shows up more clearly on MQII than on MQI differences. The adult MZ groups are most affected by whether MQII or MQI is considered the more valid measure of their ability. Every pair had scored at least 19 points on tests 4 to 7. However, only four achieved MQIs of between 100 to 120. With these rather low scoring subjects, the last four Wing tests might be liable to be more affected by differences in reliability than tests 1 to 3. The smallness of the numbers in all the groups makes them susceptible to being affected by chance differences.

The amount of intra-pair difference did not appear to be related to age in any of the child groups. Thus, the five pairs of MZ boy twins between 11:1 and 12:10 had MQs with these differences: 3, 5, 13, 23 and 24. Those between 13:0 and 14:7 showed the following differences: 1, 2, 13 (2), 14 and 22. The differences between the five youngest MZ girls (ages 10:10 to 13:3) were: 3, 6 (13), 16, 20 and 33, as compared with 0, 7, 10 (6), 11 and 23 for those aged between 13:10 and 15:5. A similar lack of consistent relationship between intra-pair MQ differences and age was found with the DZ groups. Living in the same home did not seem to be making the twins either more or less alike musically with the passage of time, at least within the age range covered by the present subjects.

With both types of twin there seemed to be some tendency for the smaller differences to be found among the lower scorers. This might be interpreted as meaning that the weaker the ear for music, the less responsive will the individual be to any stimulation in his environment, or perhaps the more marked the degree of inherited defect, the harder it is to modify. However, a pair of DZ boys had exactly the same MQs and were exactly average.

The following table shows the number of subjects in each group who played an instrument or who had had music lessons:

Table XXVIII. Number of subjects who Played or had Music Lessons

	MZ			DZ			
	Boys	Girls	Adults	Boys	Girls	Mixed	Adults
No playing	14	10	16	16	9	11	5
Some playing	4	4	0	0	3	1	1
Playing & lessons	2	6	0	2	12	6	0
Total	20	20	16	18	24	18	6

Those who were classified as having done "some playing" included some who played the piano or recorder occasionally (apparently without having had lessons), two who had received a little instruction at the piano from their mother, a pair of MZ boys who, at the time of testing, had been members of a pipe band for 5 weeks, and the adult who sometimes played the guitar.

If one MZ twin had received music lessons, so had the other. However, one boy occasionally played the piano without tuition. His MQ was only 2 points higher than his brother who did not play at all. Both were interested in music. Only one of another pair played sometimes. His MQ was 24 points higher than his brother's, but he was interested in music, while his brother was indifferent. The difference in MQ might be partly due to his being more willing to concentrate on the tests. Among the MZ girls, one who played the recorder occasionally and one who tried to play the piano on her own, both did worse on the Wing tests than their co-twins. A difference of 22 points separated the MQs of the only pair of MZ boys receiving music lessons. This pair of blind twins had been studying the piano for about 4 or 5 years and did a good deal of practice. They also played the recorder once a week. Their MQsII, though lower (158 and 135, compared with 196 and 174), were separated by almost the same difference. Among the MZ girls who were musically active, the differences in MQ were: 0, 10 (6) and 11. The two pairs with the most discordant scores (33 and 23) had never had music lessons. The difference in MQ among MZ twins do not, then, appear to be due to the effects of learning to play an instrument.

The intra-pair differences, both on MQI and MQII, are larger for the DZ girls who, as a group are much more musically active than the DZ boys. (Only one pair of the DZ boys, in fact, had had any active experience of music. The difference between their MQs was the greatest for their group - 32 points MQII or 29MQI). This might suggest that the effect of music lessons and of playing an instrument is to increase the discordance between the twins. Certainly, three individual twins who played scored much higher on the Wing tests than did their co-twins who did not play. One of these cases has been already mentioned on p.340 above, where the difference in

MQ was 55 points. In another pair, aged 14:6, twin A was very interested in music, had studied the piano for 8 years and practised for about 4½ hours per week. Her MQ was 133 (110), compared with her sister's 99 (76). Her sister was merely interested in music, her favourite radio programme being jazz; she had never learned to play. The boy of a mixed pair, aged 9, was very interested in music and played the guitar and castanets. His twin sister was indifferent to music and did not play. Her MQ was 69, the brother's 85 (still below average). On the other hand, one girl made exactly the same score on tests 1 to 3 ~~and~~ as her sister and scored 30 compared with 26 on tests 4 to 7. She had received only one term of violin tuition at school, while her co-twin had had several years of piano instruction. Both were interested in piano and said that they had enjoyed taking the test.

Among the DZ girls and the mixed pairs, the larger differences were found among those who were having lessons and who played for about equal periods, as opposed to those who were similar in not playing at all. The numbers, however, are too small to support any firm conclusion as to whether or not the training might have caused, or increased, the differences.

The following table shows the differences in attitude to music for the various classes of twin:

Table XXIX. Subjects' Attitude to Music

	MZ			DZ			
	Boys	Girls	Adults	Boys	Girls	Mixed	Adults
Attitude same	7	7	7	6	9	5	2
Attitude different	3	4	1	3	3	4	1

It would seem that there is roughly the same chance of a difference in attitude to music arising among MZ as among DZ twins.

Intra-pair differences in attitude might be supposed to affect MQ differences both because the more interested twin might be more likely to absorb more from his environment and because his motivation in doing music tests might be higher. A difference of interest did not, however, always act in the expected direction. Five out of 6 of the twins who disliked music scored higher than their co-twins who were indifferent. However, all those who were interested, as opposed to indifferent, made better Wing scores. Of the 4 who were very interested, rather than merely interested, two scored better and two worse than their co-twins.

Only very few of the twins ever attended concerts or listened to classical music at home. In the case of the only pair of DZ boys who had music lessons, twin B who listened to music much more than his brother made the lower Wing score

(MQI 125, MQII 100 compared with 157 and 129). He stated that he attended concerts of classical music 12 to 15 times a year; his brother went only twice a year. He played records of classical music for 2 hours a week and of "other music" for 3 hours a week and listened to broadcast classical music "quite often". He was attending a music appreciation class at the Trinity College of Music. Twin A claimed to spend one hour each on records of classical and of "other music" and to listen an hour per week to broadcast classical and modern music. He did, however, devote 5¼ hours a week playin the piano, violin and clarinet, compared with the 4 hours spent on practising the piano and violin by his co-twin. Both had had piano lessons for 10 years, since the age of 4. Twin A also stated that he composed "at Music College", but did not give details. One pair of MZ girls who stated that they played records of classical music for about two hours per week, also described themselves as indifferent to music. The effect of such "listening" on their musical ability could hardly be great. Even those who heard a certain amount of good music, nearly always heard a good deal more jazz. There appeared to be no consistent relationship between the amount of listening to popular and dance music and the intra-pair differences.

The writer tried to collect some data on how far the twins were similar or different in their preference for books, broadcast programmes, sports, hobbies or school subjects, and how much they tended to stay together rather than go about with a different set of friends. The replies of one individual were not always consistent with those of his co-twin. Some of the younger children were perhaps not quite old enough to have cultivated separate interests. The writer, however, attempted to classify each pair under one of three headings: I. Alike in most ways on which information could be collected; II. Alike in some ways, unlike in others, and III. Unlike in many ways. Most of the twins showed sufficient differences to be placed in class II. More of the DZ twins were, as might be expected, not very alike in their interests and preferences. Two pairs of girls, judged monozygotic and close in MQ, seemed to have quite marked differences in their tastes.

When intra-pair MQ differences were compared with these classifications, there seemed to be no consistent tendency for those most alike in MQ to be more or less similar in other ways. In the one case of a specifically mentioned difference in liking for music (referred to on p.340), there was a large discordance in MQ. This lack of association between general similarities and differences and the extent of differences in MQ is possibly to be expected in the case of a relatively specific ability such as musical ability.

It is possible that, if more of the twins had grown up in highly stimulating musical environments, more marked differences in MQ might have arisen. Any such differences might have been more likely to be found among the DZ than among the MZ pairs.

Intra-Pair Correlations of MQI and MQII

Table XXX shows the intra-pair correlations and the heritability indices for MQI and MQII. The indices were calculated using Holzinger's formula (see p. 183).

Table XXX. Intra-Pair Correlations and Holzinger's H. Indices

MZ Subjects (n. in pairs)	MZ r	DZ Subjects (n. in pairs)	DZ r	Holzinger's H_2 (h^2)
Music 1 Quotients I				
20 child	.846	20 child (like sexed only)	.761	.356
20 child + 8 adult	.789	30 child + 3 adult	.677	.347
Musical Quotients II				
10 boy	.899	9 boy	.734	.617
10 girl	.482	11 girl	.633	
10 boy + 10 girl	.838	9 boy + 11 girl	.719	.423
8 adult	.483	9 unlike sexed child	.728	
20 child + 8 adult	.794	29 child + 3 adult	.721	.262

The extreme MQI scores of the pair of blind MZ twins were found to have a serious effect on the results. When they were included with the 19 other child pairs the correlation rose from .770 to .897. Even with the full MZ group, the correlation was increased from .724 to .848 if they were included. It seemed better to use their MQII scores, therefore, for the MQI calculations, since these deviated less from those of the rest of the group (see p. 333). The pair of DZ twins whose MQs differed by 88 points were left out of all the MQII calculations and included only in the MQI calculations for the full group. As implied on p. 340, the very large difference in their MQs probably requires verification by retesting.

In the present instance, the twins of unlike sex were more alike than the girl DZ pairs. The correlation for MZ girls is relatively low and is in fact almost the same figure as obtained with the adults. The lower correlation obtained from the MZ adult group might seem to argue for the importance of environmental influences. However, though all except one professed to b interested in music, they may well have been less willing subject for the Wing tests than the children. Their MQII median was only 56.7. But taking an assumed minimum for tests 4 to 7 had more effect than with the children. The median of their MQI was 68.

One pair of twins in particular contributed to lowering the correlation of the MZ girls to .482. This pair might have been misclassified as identical, but they were certainly extremely alike in appearance and there seemed no good reason to exlude them. Apart from the girls considered alone, all the groups show a definite difference in level of correlation between the identical as compared with the fraternal twins. The MZ correlations, when compared with those obtained for intelligence, are on the whole at least as high as Shields's figures (see p. 181), but not so high as Burt's or Newman's, except in the case of the boys alone. The DZ correlations, except for girls alone, are higher than Burt's or even Newman's for intelligence among DZ twins.

The h^2 indices obtained by using MQI were reasonably similar to the comparable results with MQII. The highest, .423, is perhaps likely to be most indicative of the true position, since adults and unlike sexed twins are excluded and it is based on tests 1 to 3 which are less likely to be affected by chance than the appreciation tests with the present subjects. All the indices are lower than those reported by Burt (.83) and by Newman (.68) for intelligence. Except for boys considered alone, they are lower than that found by Shields (.53). (Shields, however, had only 7 pairs of DZ twins, since his investigation was mainly concerned with identical twins). It would, however, be unwise to conclude from the present evidence that hereditary factors are less important in musical ability than in general intelligence for the following reasons:

a) The numbers are rather too small for the correlations to be really stable. Thus, at an earlier stage of the investigation, the correlation for DZ boys (n. 6) was

.628 and for DZ boy and girls pairs of like-sex .644 for MQII. The h^2 indices were then .789 for the boys and .603 for boys and girls. When three more pairs of boys and one more pair of girls were added, correlations rose to .734 and .713 as shown in Table XXX and the MZ/DZ contrast was reduced.

b) The level of difficulty of the tests may affect the correlations and heritability indices obtained. Thus, Vandenberg (1962, p.226) reported that different results were obtained with parallel forms of a Gestalt Completion Test and of a Mutilated Words Test. The hereditary control was more clearly established for those alternate forms of the tests on which the subjects performed better on the average. On the other hand, if it were true that tone deafness or some defect was more hereditable than positive ability, the extent of hereditary control might be greater among the present unmusical subjects than among the general population. But, without tests specially devised for low levels of ability, one suspects that any hypothetical higher degree of hereditary control among the unmusical would not compensate for the greater possibility of their answers being affected by guessing, lack of interest in being tested etc. With the present subjects, who were mostly unmusical, one could not expect the Wing tests to be as reliable as intelligence tests. (However, a coefficient as high as .84 for identical child twins might be claimed as evidence that at least the first three Wing tests have good reliability, even at low levels of musical ability). Taking into account that the tests and the writer's classification of the type of twin might be less reliable, the present results would seem not to be inconsistent with innate factors playing as important a part in musical ability as in general mental ability.

The highest h^2 was found among the boys in spite of the high correlation for the DZ boys. It might be argued that these boys have departed less from their musical endowment than have the girls merely because boys usually receive less encouragement to develop an interest in music and less opportunities of learning to play. It is true that, as a group, the MZ girls had a more favourable attitude to music: 5 were very interested, 7 interested, 5 indifferent and 3 disliked music. Only 2 of the boys were very interested, and 6 interested in music, while 9 described themselves as indifferent and 3 disliked music. In 6 cases, someone else in the girls' homes played an instrument; this was true of only 4 of the boys' homes. This had, however, apparently little effect on the Wing scores of the children: 2 of the girl pairs and 2 of the boy pairs were above the median of their groups and 2 in both cases were below. As was pointed out on p. 345 above, learning an instrument or having an interest in music did not appear to be particularly related to the extent of intra-pair differences.

Such environmental factors, in so far as they could be assessed by the present data, do not seem to account for the sex differences. It is possible that the differences in levels of musical ability between the groups might have had some effect. The medians for the MZ boys was 70, for the girls 65, while the medians for the DZ twins were 57.5 for the boys and 80 for the girls. If the tests were less reliable among the more unmusical children, this might tend to depress the correlations. However, the correlation among the least musical group, the DZ boys, was higher (.734) than that among the DZ girls (.633), who were the most musical group. The correlation for the DZ boys was in fact the highest to be found among the DZ coefficients.

The number of DZ adult twins was too small for separate correlation. However, the low correlation found for the MZ adult twins, .483, rose to .741 when the three pairs of women were left out.

There might be some connection between this sex difference between the twins and the difference in percentage between boys (7%) and girls (1%) who are monotones at the age of 12 or 13 (see p. 275). Bentley (1963) himself was inclined to believe that the 4% of individuals who are still monotones at 12 (according to his survey) may be the same 5% of the adult population of both sexes who are tune deaf according to Fry's findings (see p. 232).

Fry did not give separate percentages for the two sexes. If tune deafness is in fact largely genetically determined and if males are more likely to be affected, one might expect that the sex difference would appear among the unmusical boys of the present sample. However, why some monotones "outgrow" or overcome their deficiency while others do not requires further investigation.

Other results

The twins whose scores for tests 4 to 7 were above the level of chance were correlated separately to see if the results for the full Wing battery would be different from those discussed above. Unfortunately, only 7 of the MZ child twins, 4 pairs of boys and 3 pairs of girls, scored above 19 on tests 4 to 7. All the 8 adult MZ pairs, but none of the DZ adults, made at least the minimum score. Of the 13 pairs of DZ children, 4 were boys and 8 were girls, one being mixed. The results for the MZ groups were considerably affected by whether or not the blind twins were included. The coefficient for the 6 children rose from .854 to .950 when the highly talented pair was included. Even the full MZ group (6 children and 8 adults) was affected, the correlation being increased from .585 to .875. The correlation for the 13 DZ children was .660.

Vandenberg reported the results of using Wing test 2 and Wing test 3 with the subjects who took part in the Michigan Twin Study (see p. 192). Though the reliability of the Wing subtests taken separately is likely to be lower than that of the full battery or of the combined total from tests 1 to 3, it seemed worthwhile attempting to compare the results from the younger children of the present sample with Vandenberg's. The average age of the boys (24 MZ and 14 DZ pairs) tested by Vandenberg was 16.16 years, that of the girls (21 MZ and 23 DZ pairs) was 16.39. The mean ages of the children tested by the writer were as follows:

MZ		DZ		
Boys	Girls	Boys	Girls	Mixed
13:0	13:4	13:9	14:4	12:4

The mean scores of Vandenberg's male subjects were 18.30 on test 2 (pitch) and 16.40 on memory. The maximum for each test is 30. His female subjects' scores averaged 17.20 on test 2 and 15.99 on memory (Vandenberg - private communication). These marks are reasonably comparable with the averages which Wing (1941a, p.390) obtained with his two tests from English higher school children aged 16. The mean scores for the present MZ children were 13.90 for pitch and 12.27 for memory, those for the DZ children being 16.67 and 13.77 respectively. The MZ children's medians were: pitch 14.4, memory 12.3, while those for the DZ pairs were: pitch 16.2 and memory 13.5. These scores are reasonably close to the level reached by the average child according to Wing's graph which shows the improvement of performance with age (Wing, 1941a, p.390).

While some of the older twins tended to make higher scores, a large proportion were below the average of the group, especially in the case of the pitch test. The correlation with age with both types of twin combined was found to be .052 for pitch and .353 for memory.

The intra-pair differences in marks for test 2 (pitch) were as follows:

MZ			DZ			
Boys	Girls	Total	Boys	Girls	Mixed	Total
3.3	3.5	3.2	1.7	3.5	4.1	3.0

The differences among the DZ boys were particularly small. In one case both twins made the same score (though their answers were different) and in four cases the difference was only a single mark. The greatest difference was only 5 marks. Among the DZ girls, one pair had the same score and five a difference of only 1. However, in one case the difference was 10, in another 11. In the other groups of twins, the differences were more uniformly divided.

The intra-pair correlation on test 2 for the 20 DZ twins was higher, .767, than that for the 20 MZ twins, (.558). The sexes were not correlated separately, as it was thought that the results from the subtest might not be sufficiently reliable with very small numbers.

The intra-pair differences on test 3 were found to be as follows:

MZ			DZ			
Boys	Girls	Total	Boys	Girls	Mixed	Total
2.6	1.6	2.1	5.3	3.3	2.6	3.8

The differences for this test are definitely smaller among the MZ twins. Three MZ boys and 3 MZ girls had the same scores as their co-twins. Resemblances among the girls were greater than among the boys.

The intra-pair correlation for the MZ twins was .795. As this result seemed to promise a reasonable degree of MZ/DZ contrast, the correlation for DZ twins of like sex was calculated as well as that for all the DZ child pairs. The results were found to be similar: .563 for the like sexed pairs and .541 for the full group.

It was thought that the correlation with age would be similar for both types of twin. When age had been partialled out by Newman's (1937, p.95) formula for use with intra-pair correlations, the following results were obtained:

20 MZ twins	$r = .766$	Holzinger's $H = .532$
20 DZ like sexed twins	$r = .500$	

This h^2 index is higher than any found for MQ except when boys alone were considered.

The MZ/DZ contrast both in mean intra-pair differences and in correlations suggest that musical memory as measured by Wing test 3 is more under hereditary control than is pitch discrimination as measured by Wing test 2. In this the results of the present investigation would seem to confirm Vandenberg's findings, though a different method of calculating h^2 was used.

If the same formula as Vandenberg used (see p. 192) were adopted, the h^2 would rise to .642, appreciably higher than the figure he obtained (.42).

Many of the children found the Musical Knowledge questions difficult. The mean MZ score was 4.07 (boys 3.75, girls 4.9), the mean DZ score 5.17 (boys 4.9, girls 5.4). The intra-pair correlations were .721 for the MZ twins and .509 for the DZ pairs of like-sex - both rather lower than the corresponding MQ correlations.

Conclusions

If the sample of parents and children tested for the first part of this investigation was unrepresentative in being more talented than average, most of the twins were much lower than average in musical ability.

Except when the girl twins were considered on their own, all the correlations of MZ pairs in table XXX were definitely higher than those of the comparable DZ groups. The h^2 indices ranged from .262 to .617. The highest was found among the small groups of boys. As was the case with the high father-child correlation discussed in Chapter IX, this apparent sex difference could not be explained by such data as were collected on the musical environment. Future research workers might find it worth separating their results into sexes to see if this difference could be verified or disproved.

Such variables as age, amount of musical training and of listening to music did not appear to have any consistent relationship with the intra-pair differences of the present sample of twins, most of whom came from unmusical homes.

In the case of Wing test 2 considered separately, a higher intra-pair mean difference and a lower correlation were found for the MZ child twins than for the DZ pairs. The h^2 index for test 3 (memory), .532, was obtained from correlations with age partialled out. These results would appear to support Vandenberg's findings that ability to perform test 3 is more influenced by hereditary factors than is the ability measured by test 2.

CHAPTER XI

PRESENT INVESTIGATION: IDENTICAL TWINS BROUGHT UP APART

Introduction

Mr. Shields very kindly searched the records of the sample of identical twins brought up apart who had been studied by the M.R.C. Genetics Research Unit (see Chapter VI) for those who might be willing to have their musical ability tested. All of the twins who were asked did in fact agree to co-operate.

The writer was able to test, or have tested, five pairs. In two cases, only one twin lived in the London area and was tested by the writer, arrangements being made for the co-twins to be tested in their own locality. It was not thought that, with a test such as the Wing, any appreciable difference would be caused by the tests not being administered by the same person on the same occasion.

The case numbers and pseudonyms used in the published report (Shields, 1962) have been adopted in the following brief accounts of what could be discovered about the twins' musical past, and how it might have affected the Wing test results.

Case S m 6, Age 38

FOSTER	Wing score 73	Musical Knowledge 8
FRANCIS	Wing score 75	Questionnaire not returned

Separated at 6 months, Foster was adopted by a paternal aunt and uncle, Francis remaining with his parents. They were brought up in the outskirts of a large northern town. They went to different schools, but met during the school holidays.

Francis, like other members of the family in which he was brought up, was taught to play the cornet and other brass instruments. He now plays the B-flat bass in a band. At the time of testing, he had been a member of the band for 24 years. He stated that he was very interested in music. Foster provided the following account of his experience with music: He used to listen to gramophone records every day from the age of about 6 and enjoyed comic opera and band music. When the family acquired a radio, any military or brass band programme usually held his attention, especially if it consisted of marches. He detested school music lessons, as they consisted solely of singing. At about 10, he wanted to join the local brass band, but was unable to do so. He started to learn the banjo, but gave it up after two years. Two months before he was tested, he had begun to learn the E-flat bass. His 9 year old son had begun to learn the cornet and the father thought that they could help each other in their lessons. He appeared to be thoroughly enjoying playing. He now enjoys listening to light classical music and music from shows, but not to Pop music. His adoptive father, as well as his uncles, played in Brass bands.

24 years of playing in a Brass band, as opposed to 2 months lessons and an interest in listening, has increased Francis's Wing score by only 2 points. The subtest results are very alike:

	Test	1	2	3	4	5	6	7
Foster		11	18	16	7	5	8	8
Francis		12	17	16	9	8	6	7

Case S m 12 Age 57

JAMES Wing score 56. Tests 1-3 36, 4-7 20.
Musical Knowledge 6.

ROBERT Wing score 78. Tests 1-3 47, 4-7 31.
Musical Knowledge 9.

Separated at birth, Robert was brought up by a paternal aunt and uncle, James by his natural parents. Both were brought up in mining villages in a northern county. They met occasionally during adolescence. At 24 Jim moved to the South of England; they have rarely met since.

Robert stated he was interested in music and now listens to Pop music for about 3 hours a week. He had piano lessons for a year when 12 years old, and heard music in his home for about one hour a day as a child. Jim claimed to be very interested in music. As he was brought up in a large family, there was no money for music lessons. However, his father and mother sang. His father was said to have won prizes for singing in public-house competitions. As a young man, Jim sang with other miners at work and on street-corners. His present tastes for music are slightly more sophisticated than Robert's. He attends concerts at the Albert Hall and listens to classical music. He likes ballet music and Tchaikovsky, while Robert prefers Strauss. He is also more intelligent than Robert. He might have been expected to make a higher Wing score than his brother. When tested by the writer, he appeared to be interested, grasped the instructions very quickly and concentrated well.

Case S f 7, Age 42

JENNY	Wing score 74. Tests 1-3 49, 4-7 25. Musical Knowledge 5.
KATHLEEN	Wing score 72. Tests 1-3 43, 4-7 29. Musical Knowledge 7½.

Separated by the death of their mother at birth, they were looked after by different paternal aunts, Jenny in a London suburb, Kathleen in a small seaside town, where she was visited regularly in the summer by Jenny.

Both claimed to be interested in music. In her letter agreeing to be tested, Kathleen remarked that music was her particular interest, though she could neither play nor sing. She had had piano lessons from the age of 12 to 14. She goes to concerts "whenever possible" and listens to about 6 hours classical music a week. Jenny had one year's piano lessons when she was 9, goes to a concert once a year and listens chiefly to operatic music for about three hours per week. Her sister played the piano occasionally at home when she was a child and she listened sometimes to the radio, mostly to dance music. Kathleen's cousin played the piano frequently; she too listened mainly to Charlie Kunz and to dance music as an adolescent.

The London twin was tested by the writer at the Institute of Education, while Kathleen was visited in her home by a member of the local County Music Organiser's staff.

Case S f 8, Age 43

OLIVE Wing score 90. Tests 1-3 54, 4-7 36
Musical Knowledge 6

MADGE Wing score 110. Tests 1-3 68, 4-7 42
Musical Knowledge 12.

Separated at birth, these twins did not meet for family reasons from the age of 3 till about the age of 39. Olive was brought up by her own parents, Madge by a paternal uncle and aunt, who sent her to a private school and encouraged her to become a piano teacher. She gained A.L.C.M. and A.T.C.L. diplomas and, apart from clerical work in a factory during the war, worked as a piano teacher. At the time of testing she had, however, given up this profession and, like her twin, become an assistant nurse. She still tries to play the piano, for an hour per week, when possible. Her twin also plays a little and had piano lessons for two years from the age of 10. Their father played the piano and won diplomas of the Royal College of Music when young. Olive, living in the same home, had the advantage of hearing him and her brother play. She reported that they played the piano once a week and the mandoline every day. From the age of about 14, she listened to music, mostly light classical or organ music, on the radio or gramophone every evening, but did not attend concerts. Madge attended two or three concerts a year; in her home there was a radio or gramophone from the age of six and she quite often listened to orchestral and some light music. No one else at home played.

The twins were tested together and reported to be most co-operative. It is possible that some of the higher Wing score made by Madge was due to her feeling more confident than her sister. However, it seems likely that her very much greater experience of music - up to professional (teaching) standard - accounts for much of the difference. Olive's score is well above average, more than could be accounted for by her musical background. Her score on test 2 was 27, compared with Madge's 26. All her answers to test 5 were correct; Madge made only one error. On the other hand, she scored only 10 on test 1 and 5 on test 6, while Madge scored 17 and 10. It seems reasonable to suppose that both have inherited their talent from their father. It is interesting to note that they had similar tastes in music, as in clothes and books. "One mentions Tchaikovsky's first, the other Rachmaninov's second piano concerto as among her favourite compositions. Olive likes the Messiah best of all. On top of a pile of music in Madge's room was a copy of the Messiah. Although she plays only a very little herself, Olive says 'music is a big influence in my life'". (Shields, 1962).

Case S f 17, Age 49

JACQUELINE Wing score 79. Tests 1-3, 46, 4-7 33
Musical Knowledge 5.

BERYL Wing score 64. Tests 1-3 40, 4-7 24.
Musical Knowledge 8½.

Separated at birth, Jacqueline was looked after by a paternal uncle and aunt, Beryl by a distant cousin of her mother, living in different London suburbs. They did not meet till the age of 16.

Both claimed to be interested in music. Jacqueline had piano lessons for 7 years from the age of 14. Her adoptive father conducted a church choir till the age of 80. When at home, he was always wanting to have radio music programmes turned on. Various relatives came to the home and made music. A neighbour who later became a music teacher often came and played the piano. In later life Jacqueline became chairman of the music section of her local Townswomen's Guild and conducted their choir. Beryl, on the other hand, had never had music lessons, though she belonged to a choir. No one in her home played, though one member of the mother's side of the family was described as "musical". The music she listened to at home when an adolescent was light, as compared with the orchestral music to which her twin used to listen. When she visited the Maudsley Hospital to take part in the original investigation, she was twice noticed to be singing to herself.

The twins periodically met to spend a day in Town together. On one such occasion they came to the Institute of Education to be tested. Though their attitude to being tested appeared fairly light-hearted, they soon settled down and concentrated well. In spite of her fairly extensive experience of music, Jacqueline's Wing score was only 3 points above the adult mean according to Wing's norms. Her higher score might perhaps be attributed to a more favourable musical background and to better opportunities to learn an instrument and to take part in musical activities. It is worth noting that her score on the intelligence tests administered at the Maudsley was higher than her twin's; this pair of twins were among the 24% of the group brought up apart who had a difference in their raw scores of over 15 points.

Conclusion

The number of the separated twins who could be tested is too small for average intra-pair differences to be meaningful. To summarise, the following differences in Wing scores were found: 2, 2, 12, 15 and 20. In comparing these with the differences found among the twins brought up together, it should be remembered that a difference between MQ points is roughly twice the difference between raw scores.

In one case a difference of only two marks was found between the two men in spite of a considerable difference in experience of instrumental playing. On the other hand, the possibility of improving musical ability, as measured by the Wing tests, might perhaps be suggested by the difference of 20 marks (40 MQ points). But this difference occurred where one twin had enjoyed the opportunity of training up to the standard required for a piano teacher's diploma. Her greater experience of music may also have given her more confidence in attempting the tests. It might only be among persons with a high degree of innate musical capacity that differences of training could produce such a difference in test performance. Individuals with lower initial endowment might be less able to respond to environmental influences.

CHAPTER XII

PRESENT INVESTIGATION: OTHER RESULTS

R.M.S.M. JUNIOR MUSICIANS

Introduction

Material from the Senior Psychologists' Department of the Admiralty was made available to the writer to examine for evidence on the relationship of musical ability to a) intelligence; b) other abilities; c) educational background; d) social status, as indicated by father's occupation; and e) spare-time interests.

The seven Wing tests of Musical Aptitude had been experimentally given to 223 junior musicians already in training at the Royal Marines School of Music, to ascertain if the use of these tests would improve selection to the School.

The questionnaires filled in by the boys at the time of their recruitment and their scores on two batteries of general and educational ability were also available.

Musical Ability and General Intelligence

The following coefficients were obtained by correlating the Admiralty General Intelligence (Abstraction) test with the junior musicians' Wing scores:

Intelligence and Wing tests	1-3	.188
	4-7	.218

As some 80% of the boys had come from Secondary Modern schools, a higher degree of correlation might have been expected (Cf. Chapter III). The low correlations may be due to the effects of selection. Two selection effects may have been involved: firstly, only successful recruits were included and secondly, the least musical of the group were those most likely to owe their acceptance for training to other compensatory qualities of general ability or character.

<u>Musical Ability and Other Abilities</u>

The results of correlating Wing tests 1-3 and 4-7 with Admiralty selection battery of Mathematical, Mechanical, Spatial and Spelling tests were as follows:

Mathematical	and Wing	1-3	.074
		4-7	.053
Mechanical	and Wing	1-3	.257
		4-7	.024
Spelling	and Wing	1-3	.119
		4-7	.123
Spatial	and Wing	1-3	.208
		4-7	-.032

In each case except Spelling tests 1-3 show a somewhat higher correlation than 4-7. Taste and appreciation would seem to be even less closely related to intellectual ability than are aural acuity and memory, but the differences are not great.

Zero correlations occur in the case of mathematics. Reference has already been made in Chapter III to the differences between music and mathematics as school subjects. The Admiralty Mathematical tests, which are largely arithmetical, must be considerably affected by the candidates' previous experience, though they would also measure ability to deal with numbers. Even the problem part of the tests do not call for any advanced mathematical problem solving.

Comparable with the Admiralty Spatial test are the two tests, Gottschaldt's figures and Thurstone's Identical Forms, included by Franklin in his larger Study of musical ability (see Chapter III above). As in Franklin's results (except that for Gottschaldt's figures and Rhythm), the last four Wing tests show a zero correlation with Spatial ability. In the present instance, there is a more definitely positive, though low, association with the first three Wing tests.

Musical Ability and Educational Background

Two hundred of the junior musicians were divided into 5 groups according to their total Wing scores. The questionnaires filled in at the time of their recruitment were inspected for the type of school attended. The schools were classified under three headings: Grammar, Secondary Modern and other. Owing to the large number, pupils from Secondary Modern Schools were further divided into Above Average, and Average or Below. The replies of the boys were checked as far as possible with the remarks of the recruiting and Royal Marine Officers.

School	Top	Second	Middle	Fourth	Bottom
Grammar	7	6	5	0	7
Secondary Modern, above average	11	12	9	16	13
Secondary Modern, Average or below	16	18	23	21	19
Other	6	4	3	3	1
Total	40	40	40	40	40

$X^2 = 14.83$ df $= 12$ $P = 0.30$

The differences are not statistically significant. The rise in the number of boys from Grammar schools in the lowest group would tend to confirm that the least talented musically owe their acceptance in part to a better educational background.

Musical Ability and Father's Occupation

In some cases no information was given on the questionnaire about the father's occupation, often because the father was dead or divorced. (No doubt boys without fathers tend to be encouraged to join a Service school).

The classification of occupations was adapted from that used by the Scottish Council for Research in Education for the 1947 Scottish Mental Survey. Owing to the small numbers, codes 10 (professional), 30 (self-employed), 41/42 (Salaried) and 70 (farmers) were combined. Agricultural workers (Code 80) were included with 62 (Semi-skilled manual workers). Engineers were mostly included with the Salaried group.

	Top	Second	Middle	Fourth	Bottom
Wing scores	112 84	83 77	76 71	70 64	63 33
Codes 10, 30, 41/42, 70	9	10	7	2	7
Codes 51/52 (non-manual wage earners)	7	7	8	14	12
Code 61 (manual - skilled)	9	7	6	5	6
Code 62 (manual - semi-skilled)	8	13	12	10	12
Code 63 (manual - unskilled)	7	1	4	5	1
	40	38	37	36	38

Chi squared = 20.96 df 16 P = 20.

The differences are, thus, not statistically significant. This may be partly due to there being so few representatives from the most cultured homes. A soil chemist, an electrical engineer and a teacher were the highest level of socio-economic status included. Moreover, no information was available about the early home background of the boys' mothers. This might be important in the case of a subject like music.

In so far as the socio-economic status of the home is indicative of opportunities to develop an appreciation of music by listening to good music and receiving instrumental lessons, the Wing tests do not appear to be affected by such environmental influences. If the two top grades are taken together, the members from the highest social category are more than double those from unskilled workers. However, 7 boys out of 18 whose fathers were unskilled manual workers have sufficient talent to benefit from instrumental training.

While it is highly desirable that talented children from less favourable home backgrounds should receive every encouragement to develop their talent, the differences between selection for musical training in the Services and for special opportunities of learning music by a child still at school and living in a poorer home must be recognised. Without the special facilities for practice of a residential Service music school, the child of the manual worker may find less understanding from the rest of his family of the need to practise and to listen to good music. Unless some degree of appreciation of good music can be fostered among his school-fellows (or some tradition of music-making is present in his part of the country), he may be rather easily tempted to give up music altogether or at least to divert his talents to jazz or dance-music. (This would depend on individual circumstances. Many parents of children whose achievements in other directions were below average might be all the more inclined to feel proud of a child with musical talent and be anxious to give him all possible help in fostering it).

Musical Ability and Spare-Time Interests

The candidates were asked to state their main spare-time interest. The replies were analysed as follows:

	Top	Second	Middle	Fourth	Bottom
Music	18	18	19	9	9
Sports	6	6	14	10	15
Cadets, Scouts etc.	4	5	2	4	5
Constructional	5	5	2	0	2
Collecting	4	2	1	5	4
Other	3	4	2	12	5
	40	40	40	40	40

Where a boy gave two replies, if one was music that was taken as his main interest, otherwise the first mentioned was counted.

There appears to be some tendency for the more musical to be less keen on sport and more interested in constructional hobbies, but chi-squared was calculated only for the difference between music and all other interests. The probability was found to lie between .05 and .02.

This range of probability suggests a moderate, but not unduly high, positive association between the boys' Wing scores and their interest in music. It could be expected to be higher than Wing's coefficient of .30 (1948, p.79), obtained from boys of similar age and possibly of similar backgrounds since the R.M.S.M. boys were taking up music as a career. However, no less than 55% even of the two top groups did not give music as their main spare-time interest.

Besides being asked to state their main spare-time interest, entrants were also required to underline from a list of varied activities any which they also did in their spare time. The following table shows the number who took part in musical activities:

	Top	Second	Middle	Fourth	Bottom
Playing music	33	33	27	31	26
Concert party work	9	3	6	3	4
Listening to music	38	35	36	33	28

The bottom group would appear to have the least spare-time music experience - 30% do not even listen to music, while only 22½% of the two lowest groups stated that music was their main spare-time interest.

The non-musical activities are tabulated as follows:

	Top	Second	Middle	Fourth	Bottom
Sports 2 or less	7	14	6	10	10
3 or 4	17	15	27	20	20
5 or more	16	11	7	10	11
Practical none	17	17	13	6	13
One	11	11	11	19	16
2 or more	12	12	16	15	11
Reading	36	31	30	29	28
Cinema	27	23	22	19	28

Conclusions.

The above data confirm that musical ability appears to be largely specific.

In the present highly selected group no significant degree of association appeared to exist between levels of musical ability as measured by the Wing tests and educational background or socio-economic status.

A positive relationship between interest in music and Wing scores was found to be statistically significant at the .05 to .02 level.

CHAPTER XIII

PRESENT INVESTIGATION: FACTOR ANALYSES

The aim of the present factorial study was to compare the results obtained with the same battery of tests, Wing's, on five different groups. It was thought that these factor analyses might throw some light on certain problems in musical psychology, e.g. on the relative efficiency of the seven Wing tests at different ability and age levels; on how far musical ability depends on a general factor; if the musical ability of the highly talented differs in kind as well as in degree from that of the average person; and on sex differences which might be related to the greater amount of encouragement and opportunities to learn music which girls tend to receive.

The Subjects and Experimental Procedures

Groups 1 and 2 were similar in age and general educational background but differed in expertness in handling music. Group 3 was similar to group 1 in being highly talented, but differed in age. Groups 4 and 5 were comparable in all respects, including level of musical ability and differed only in that group 4 were all men and group 5 entirely women.

Group 1 consisted of 41 students of both sexes of the Eastman School of Music in the University of Rochester, U.S.A.

(Cf. Wing, 1962, p.42). These were all expert performers many of whom were likely to take up music professionally. All their scores on the Wing tests were high, reaching professional standards (see Appendix VII). Their general intelligence and educational background were sufficiently high to match reasonably the students of group 2 from the City of Sheffield Training College. It would not be easy to find in England a group of musicians of sufficient size and of comparable level of general ability. The students in the Music Departments of British Universities are usually few in number (and sometimes not so much players as theoreticians). Music colleges would provide good instrumentalists, but their general ability might not match up to the intellectual standards of the Sheffield students.

Group 2 consisted of the 100 students, 48 men and 52 women, out of nearly 200, whose scores were nearest to the adult average (76) for the Wing tests. Sixty were in fact in Grade C, 20 in Grade D with scores of 68 or over and 20 in Grade B with scores up to 89. Their mean score was found to be only 1.46 marks above Wing's average (see Appendix VII).

Group 3 was the only group of children included in the present study. These 100 gifted child performers, all members of the National Youth Orchestra, ranged in age from twelve to eighteen years (Cf. Wing, 1954, p.164). All except 3 fell into grade A for the Wing tests. A high proportion of these children later become professional musicians.

Groups 4 and 5 were selected to provide 100 men and 100 women of above average musical ability from Sheffield Training College students. The highest scores (above 110) were omitted. The lowest scores included were 78. The means obtained were in fact very similar. (Before selection, the average for the women was possibly slightly higher. At least, the writer had the impression that she had to look at a rather larger number of the men's results to obtain the 100 above average age scores than was the case with the women). This higher level of ability was adopted, as being the one at which the Wing tests are most reliable and valid (Wing, 1960).

It is not claimed that any sex differences found between groups 4 and 5 would necessarily apply to other young men and women. For instance, young men or women who decide to enter the teaching profession may differ in their attitude to, and appreciation of, music from their former class-mates who are making their careers in commerce or industry. On the whole, the women were generally better qualified than the men (since more well qualified men go to University).

All the subjects were tested in large groups. In the case of the National Youth Orchestra children, the disc recording of the tests was used; in the longer form, with the last four tests having 20 items. The other groups were tested with the (1961) shortened version of the test, tape-recorded at 7½ ips. (The tape and disc version have high intercorrelations).

The correlation matrices for each of the five groups were factorized separately by the method of Principal Components Analysis, a programme for which was available at the University of London Computer Unit.

The Relative Efficiency of the Wing Tests

Test 1

The mean score for this test rises from the average group (9.97) through groups 4 and 5, who may be considered above average, to the considerably higher mean (15.76) of the Eastman group. The standard deviation, however, does not fall. The test, as judged by that criterion, seems to be still good for separating the good student from the very good one. Its power as a test for the gifted is reflected in its high loading in Factor I. In use, this seems to be a test which is most effective over a wide range of aptitude. (Even if it were not particularly useful, it might be worth retaining in the battery, as it takes only three minutes to play and might serve as a "warming-up" period for the subjects). The opinion of early workers in the field of psychological musical testings, such as Stumpf and Revesz (see Revesz, 1925) as to the value of chord analysis as a diagnostic test of talent would seem to be justified. It is interesting to contrast Erwin Nyiregyhazi's ability to name the notes and recognise complex chords with that of the Eastman students at the relatively more simple task of detecting if a chord contains one, two, three or four notes. The present data do not show how good the latter might be at recognising chords - a task easier to accomplish from live, rather than recorded, music. But though they were much older than Erwin, they would probably have been much less proficient than he at this particular aural task.

Newton's analysis did not show test 1 as being among the most efficient at discriminating between the above average and the below average of the R.M.S.M. junior musicians. But, as Newton himself suggested (1959), the apparent lower validity of some items of this test might have been due to recording or reproducing faults.

Test 2

The mean score for the Eastman students is 29 out of a possible 30. This test is so easy for the very able that it becomes less useful for separating them. The standard deviation falls too, as there is less headroom for the test. But the results from groups 4 and 5 would indicate that even up to the above average adult level it can still give a good spread: that for the women being higher than for the average group. It was one of the most effective in the case of the R.M.S.M. junior musicians, particularly at picking out those who were below average.

Test 3.

Similar remarks apply to a lesser degree to the memory test, where the mean for the Eastman group rises to 25.5 (out of 30) and the standard deviation falls. At the level of groups 4 and 5, it still works well, the men and women making almost the same mean scores. It was the most effective of all the tests with the R.M.S.M. group, Newton reporting that 24 (out of 27) of the Above Average boys making above average scores, while 17 out of 28 Below Average boys scored for this test lower than the mean score of the total group of 223 boys.

Test 4

The rise in ability to do the test has brought the mean for the Eastman students to a good level for separation, i.e. from 7.6 for the average group to 9.9 for the able (with a possible score of 14 and a chance score of 4.7). Its loading for Factor I also rises from .03 to .45.

Test 5

The mean for the Eastman group has in this case risen rather too much. It is now a little too high to be at its most discriminating and its loading for Factor I drops from .5 to .3. At the level of the R.M.S.M. junior musicians, it was found to be second in its efficiency only to the memory test both for distinguishing the good from the average and the weak from the average of the total group.

Test 6

As a test for the highly talented, this would appear to be effective, judging by the rise in mean score and Factor I loading between the average and Eastman groups. The average scores for this and the next test were rather too low to allow good discrimination with the Average group. These last two tests of the battery are especially liable to be affected by fatigue, lossof interest and lack of concentration, particularly with less talented subjects. (From the point of view of sustaining the subject's interest, it is a pity that the first items of test 6, though attractive as melodies, are rather lacking in liveliness. They are slow, probably because they are the easiest items). Among the R.M.S.M. subjects, the means for both tests fall, especially with the below average group. In the case of test 7 their average comes very close to the chance score. As the junior musicians were being tested as an experiment, many may not have felt any particular desire to do well. If the tests were used as part of the official selection procedure, the candidates would have much more incentive to concentrate. It is perhaps noteworthy that many military bands consistently play too loudly.

<u>Test 7</u>

The mean for the Eastman students also shows a rise, perhaps becoming slightly too high for maximum efficiency; the rise in Factor I is comparatively small. This was the test which gave the highest loading on the general music factor with Wing's analysis (1941a, p.289) - a result which Wing rightly considered "quite intelligible, for the surest sign of the subject's understanding of a new musical piece is his ability to grasp the musical structure". On the other hand, Newton did not find the test among the best of the battery with the R.M.S.M. boys who were rather similar to (but slightly older than) Wing's sample. As observed above, this may have been partly due to its designed difficulty and partly to a lack of interest or to fatigue. When administered to the R.M.S.M. boys, the instructions were wholly dubbed on to the tape, partly in order to induce a set towards listening. This procedure might be effective at the beginning of the test, but it has always seemed to the writer that reading the instructions before each test was beneficial, as it enables the subject to have a short rest from listening. In the case of Wing's result, it would be understandable if the author's enthusiasm for his tests had communicated itself to his subjects so that they remained alert to the end.

Discussion of Factorial Results

In general, the correlation matrices for all the groups show lower correlations between the tests than those reported by Wing (1941) or even those reported by Franklin (1956). These lower intercorrelations were to be expected from highly selected groups, e.g. the S.D. of group 2 is only 6.126. In every case, however, each test has a positive correlation with the test total, showing that it is contributing to the total result.

As can be seen from Table XXXI and from Appendix VII a broad first factor accounted for from 26% to 35% of the variance.

Table XXXI. First Factor Loadings

Test	Group 1 Eastman	Group 2 Average	Group 3 N.Y.O.	Group 4 Men	Group 5 Women
1	.753	.320	.728	.521	.630
2	.470	.511	.543	.684	.653
3	.569	.598	.778	.490	.540
4	.449	.029	.564	.314	.021
5	.296	.500	.637	.749	.518
6	.466	-.084	.324	-.017	.590
7	.388	.364	-.013	.496	.343
Total	.999	.965		.977	.986
%age of variance	34.59	25.56	32.28	35.49	35.28

Groups 1 and 3

In the case of group 1, the most highly musical group, the loadings on Factor I were all positive and significant. The highest loadings are for the first and third test; the memory test even if relatively easy to these talented students is still an important part of their ability to handle music. Comparing the first factor obtained with the gifted children with the first factor from the Eastman group, the highest loadings in the former are again found for tests 1 and 3. Test 5 has a much higher loading, since ability to appreciate harmony is an important part of musical talent, and one which seems to develop at a relatively late age (see Chapter IV), but the test is still not as easy for these younger, though talented, children as for the Eastman students. Test 2 also is making a more important contribution than for the Eastman group. The general pattern of the loadings in this first factor for the N.Y.O. group is sufficiently similar to make it seem likely that the one negative loading might be due to some special cause. One possible explanation would be that, by the time the last test in the longer series was reached, the children were tired. The testing could take place only in the evening, after the children had spent a long day at music and when many of the younger children should have been in bed (Wing, 1954 and private communication). Another explanation that might be put forward is that phrasing is a matter which would probably have received considerable attention during the N.Y.O's meetings for intensive instruction and practice. Even if they were previously excellent performers, they might have found much to learn about the advanced details without having time to assimilate them fully. This might have had the effect of disturbing their previous ideas on the subject.

If it can be accepted that test 7 had not on that particular occasion assessed their "normal" appreciation of phrasing, it would seem reasonable to regard factor I as a general factor.

Factor 2 in the case of the Eastman group separates tests 6 and 7 from the rest of the battery and from test 3 in particular. It is not at all surprising that phrasing and intensity should be linked closely, especially among experienced performers, since these are vital aspects of playing which distinguish the mediocre from the talented. In fact, Jacobs (1960) goes so far as to query the need for separate tests of these two variables. However, he would have seen if he had had access to the music, that the two tasks are quite different. As might be expected, the phrasing test appears closely linked with the Rhythm test, rather definitely in the case of the N.Y.O. group (Factor 2), more obscurely in the case of the Eastman students (factor 5), and of the Sheffield women (factors 3 and 4). This is understandable, since phrasing is one of the aspects of music which contributes to the Rhythm (Wing, 1941a, p.249).

Factor 3 for the Eastman group separates tests 4 and 5 from the other tests and especially from the memory test. The close connection between the Rhythm and harmony tests seems quite understandable among the musically able, since harmonic progression is one of the means the composer uses to convey movement towards points of climax and repose, i.e. the "flow" of the music which is what Wing aims at testing by his appreciation of Rhythm test. There is no similar factor among the gifted children, indeed in the possibly insignificant factor 5, the two tests are contrasted. Perhaps at their stage appreciation of Rhythm is not yet closely associated with harmonic progression, even in the minds of the talented. (It is possible that this connection might develop a little less rapidly among orchestral players than among pianists who are not dependent on other players to supply the full "vertical harmonies or the other counterpoints).

In his own factorial study Wing (1941; and 1941a, p.291) found a second factor which was thought to be one which divided the tests involving judgment from those involving detection. This factor was characterised by negative loadings on the first three tests, particularly the memory test and by positive loadings on tests 4, 6 and 7 with a near zero loading for test 5. (Test 5 was found to give more positive correlation with the first three tests than did the other three appreciation tests since this test could be solved either by an 'analytic' or 'intuitive' approach). Factors 2 and 3 of the Eastman group might be regarded as corresponding to Wing's second factor in that the appreciation tests are contrasted with a high negative loading for memory. Among the more able the Rhythm and Harmony tests may have moved away from the judgment level with greater ability to detect faulty harmony or Rhythm and formed a separate factor. The intensity test was reported by Wing (1941a, p.252) to be the test most likely to be accomplished by general impression.

There is no sign of Wing's third factor, sorting tests and persons into those depending mainly on harmony and on melody respectively, in the Eastman group. Presumably their ability to deal with several notes simultaneously has merged into their general musical ability and does not provide any separate factor. Some separation of harmonic from melodic may be seen in factor 3 for the N.Y.O. group, where tests 1 and 5 have rather strong negative loadings in contrast to the positive loadings of 2, 6 and 7. It seems reasonable that pitch should be closely allied to appreciation of intensity changes and of phrasing in talented children players of orchestral instruments and that, as yet, ability to deal with several simultaneous parts remains distinct. In factor 4, however, tests 6 and 7 would appear to be allied to 1 and 5 and contrasted with 2 and 3. This possibly illustrates how tentative must be the interpretations of subsidiary factors obtained from a battery of tests based on musical material which has by its nature an inevitable unity, even when various elements are deliberately stressed in the different tests. Both factors 3 and 4 are only on the border line of significance (roots = 9.28 and 9.13).

Average Group.

Partly due to the homogeneity of the group the main factor accounts for only 26% of the variance. If the first factors for the groups included in the present study may be regarded as general factors of musical ability, the least musical group would be expected to show least evidence of a general factor. For tests 4 and 6 the loadings are around zero. Perhaps this shows that for the average person Rhythm and intensity changes are not regarded so much in their musical context as in the case of more musical persons. Perhaps less musical people turn to verbal media, e.g. poetry, to express what the musically talented express by changes of intensity in music. The relatively high loading for memory might imply that teaching from memory (by ear) has more justification for the average pupil than supporters of teaching by notation are prepared to admit.

The second factor in the present group shows similarities with Wing's second factor. In the present case, test 1 has a positive value, but it is fairly small and test 2 rather than test 3 has the high negative loading. Among the appreciation tests, test 5 has the lowest positive loading, though it is larger than for Wing's second factor. Perhaps these average subjects were less analytical in their approach to tests 1 and 5 than Wing's group. (This does not sound too likely, but might accord with Whittington's supposition (see Chapter III) that intelligent but unmusical subjects tend to use "intelligence in a finer form" to appreciate ~~approach~~ a "gestalt" quality in music tests).

Factor 3, as in Wing's analyses, seems to separate tests 1 and 5 from the remainder of the battery, which have zero or negative loadings. To a musician the values on the Rhythm and

Phrasing tests would seem unexpectedly low as musical Rhythm and phrasing are also closely associated in the musical person with chord variation. This would not seem to be the case with the average person and might be associated with the happy tolerance by the ordinary adult of the poor chord construction of popular rhythmic music. The negative loading in test 2 for this factor might be explained on the assumption that the average subject regards this test melodically.

Comparing the analysis for the average group with that for the highly talented does not suggest that the differences are of kind as well as of degree, though the latter may have a more highly evolved or developed form of ability. (This does not imply that given greater opportunities for training the ordinary person's aptitude could be developed to such a high level, though training might help towards a more unified form of ability). At least at the level of high professional talent, if not that of the great composers, there would appear to be no fundamental differences in kind such as postulated by Scheinfeld (1956) and Vandenberg (1962). (Cf. Chapter VII).

Groups 4 and 5 (Men - Women)

The present results appear to confirm the general conclusion from the discussion of the literature (see Chapter VIII): that the similarities between the sexes as to musical ability are much greater than the differences, but the differences may be interesting and significant.

As can be seen from the table in Appendix VII, the men seem to do the pitch test better than the women with a similar average score for the whole test, while the women find the last three appreciation tests easier than do the men. The differences between the means are statistically significant for test 2 (C.R. = 5.4) and for test 6 (C.R. = 3.2) but not quite for test 5 (C.R. = 2.1). Though the mean for the men on test 4 is almost identical with that for the women, the S.D. is rather higher.

In the case of the men students an appreciation of changes of intensity appears to be lacking in the main factor. An appreciation of Rhythm would seem to play a negligible part in the women's musical ability, at least as evidenced by factor I. Test 5 has the highest loading in the men's first factor, but ranks only fifth in the case of the women, perhaps because this test is beginning to become a little less discriminating, judging by the high mean and the fall in the S.D. The women seem a little less proficient at test 1, perhaps because it apparently requires a more analytical approach (Wing, 1941a, p.236 et seq.), while test 5 can be judged by the gestalt or general impression (Wing, 1941a, p.250). The most marked contrasts between the loadings on factor I of the men, as compared with the women, are provided by tests 4, 6 and 7. An appreciation of phrasing and of Rhythm seems to have a much more prominent place in the musical ability of the male group, while an appreciation of the appropriateness of intensity changes appears to be much stronger among the women. Such a difference would seem to accord quite well with the tentative explanation put forward by Wing of the rather better performance of his appreciation tests by girls at the age of 14 (see p.271). It would also seem to support his recommendation (1941a, p.408) that the intellectual appeal of music should be stressed with boys over 14, whereas for girls more emphasis should be placed on the emotional and expressive aspects. If boys tend to be more extroverted in their approach to music, Rhythm would seem more likely to appeal to them. It might be interesting to investigate whether subjects high on the introversion side of an objective personality scale tend to do better at test 4 and those who score high as introverts at test 6 and how far the results were related to the sex of the subject. It was suggested in Chapter VIII that the more distinguished achievements by men on the creative side of music might be based on some real difference of ability and not merely on greater opportunities. A greater appreciation of phrasing might then be expected from a male group, since the phrase is a smaller unit of construction.

Another way of interpreting the present results might be to attribute the higher means of the women on the last three tests to the effect of their having received a better musical education and of their having been encouraged to take a greater interest in music. That their mean score on the Rhythm test is almost the same as the men's might be explained by supposing that either Rhythm is less affected by training than other aspects of music or that any leeway is more easily made up (Cf. Chapters IV and V). But whether the difference between the sexes is due to cultural and educational differences, or to deeper inherent biological ones, or to both, the actual quantitative difference in their scores is quite small. Wing's graphs (1941a, p.401) suggest that a slightly greater increase in girls' scores may occur among children aged 15 and 16, than among the present young adult group.

The second factor for the men is reasonably comparable with Wing's (1941a) second factor, with a strong negative loading for memory and pitch and a zero loading for test 1 being contrasted with high positive loadings for tests 4, 6 and 7. Wing's zero loading for test 5 has now become negative. This might perhaps be explained by assuming that men usually adopt an analytical approach to this test. The second factor for the women, though bipolar, can hardly be regarded as similar to Wing's second factor. To judge from the separation of tests 4, 5 and 1 from the rest of the battery in factor 2, appreciation of Rhythm is closely allied to appreciation of the appropriateness of harmonic progression for women. Perhaps womeh tend to judge test 5 by the general feeling of movement conveyed by suitable harmonies, rather than analytically.

Factor 3 for the women shows a bipolarity between tests 1 and 5 (but also a weak connection between these tests and test 6), as did Wing's third factor. There is no comparable factor for the men. Taken together factors 2 and 3 for the male group separate tests 4 and 7 from 5 and 6 and 1 from 2 and 3. Factor 4 appears to be specific to test 1 versus 3 and factor 5 to test 4 versus 7. In the case of the women, factor 4 is mainly specific to test 7, but contrasts (as does factor 3), test 1 with 2 and 3.

The Effects of Rotation

The results of a possible rotation of factors 1, 2 and 3 for the Eastman group are shown on Fig. 1, Appendix VIII and in the table below:-

Table XXXII. Rotated Factors obtained for Group 1

Test	Factor I	II	III
1	.693	.319	.139
2	.478	.132	.093
3	.878	-.132	-.093
4	.246	.070	.672
5	-.082	.149	.838
6	.099	.787	-.131
7	.037	.790	-.076

Factors II and III are substantially the same as before rotation. Factor II has acquired a moderate loading on test 1 - more than has Factor III though this Rhythmic-Harmonic factor might, musically, have been supposed to be closer to test 1 than the Phrasing-Intensity factor. Weaker connections with tests 2 and 5 are now found for factor II; these would seem musically plausible.

Factor I now ceases to show a general factor. The loading of the Memory test has been increased. With any factorial analysis of the Wing tests from which subsidiary factors showing the "characteristic" larger negative loading for the Memory test have been extracted, a new axis drawn to reduce such a loading will tend to produce a similar result. Faulds's rotation of Wing's (1941) factors also produced a factor with a large loading on Memory (see Chapter II).

Factor I, then, separates the cognitive tests, headed by test 3, from the appreciation group. Test 4 still has a moderate loading. Wing's earlier results (1941a, p.251) would suggest that test 5 is the appreciation test most closely linked with the first three. However, it sould seem a reasonable supposition that for this highly talented group Rhythm has become allied with the more cognitive part of the battery and that the zero loading is due to test 5 being very easy for them.

The view of musical ability, as it exists among these highly talented students, that emerges from the rotated analysis would seem to suggest that it is composed of three factors:

1. a factor of the "basic" cognitive skills of which memory appears to be most important and rhythm the least

important.

2. an "interpretative" factor mainly concerned with phrasing and dynamics, but with links with all the other tests except memory and rhythm.

3. a factor involving rhythm and harmony distinct from the rest of the battery except from test 1.

There would be no distinctive factor which would fit with Franklin's concept of "judicious pitch" unless the fourth barely significant factor were included.

As can be seen from Fig. 2, Appendix VIII, the N.Y.O. factors 1 and 2 when plotted show a close clustering together of tests 1, 2, 3 and 5. The separation of test 7 from the rest of the battery would be emphasised in factor I, if rotated as suggested. The close alliance of tests 4 and 7 in factor II would remain, as before rotation, with connections with all the other tests except number 6. No great difference would be made if factor III were rotated - since tests 2 and 6 would still be connected and contrasted with a (reduced) negative loading on test 1 and a zero loading on test 5.

Plotting factor 1 against 2 and against 3 for the average group illustrates that the various aspects of musical ability are less well integrated than among the talented. This is a fundamentally similar comparison to that made before rotation. Psychologists like Seashore who believe that musical talent is composed of several largely independent capacities would say that the present groups 1 and 3 happen to include only those individuals who do not lack any essential capacity, while among the average group each subject is deficient in one or several abilities. On the other hand, if group 1 represents a more advanced stage of the development of a high level of talent than group 3, one might argue that some process of specialisation has occurred and that the negative loading of test 7 is indicative that phrasing is beginning to become separated from general musical ability. A parallel might be drawn with number ability which seems to show some differentiation into geometrical, scientific and other specialised abilities at higher levels (Vernon, 1960).

Rotation of the factors for the male and female groups would tend to emphasise the segregation of the intensity test, in the case of the men, and the Rhythm test, in the case of the women, from the rest of the battery.

Rotation would not appear to make the factor analysis of the Wing tests much more meaningful. As Wing himself pointed out (1941a, p.279) "with the present tests this rotation is an extremely hazy business, for we cannot ... assume that any one of the given tests is a pure test of a particular function in music".

Conclusions

Even among the present highly selected groups a broad first factor was found accounting for from 26% to 35% of the variance. The loadings were most consistently and significantly positive in the case of the most musical group and least so in the average group. In only 5 out of 35 items were the loadings around zero. It seems reasonable to claim that this broad factor should be regarded as a general factor of musical ability. Whether the unrotated or rotated factors are preferred, the talent of the highly musical seems more unified or "integrated" than that of the average person. However, the differences appeared to be in degree rather than in kind.

In the case of the male group, an appreciation of Intensity changes appeared to be lacking in their general musical ability, while the women's general ability to appreciate music was deficient on the Rhythmic side. Factor analyses of groups composed wholly or largely of any one sex might seem to be affected by such differences.

Wing's second factor was confirmed among the male group, the average group and, split with a third factor, for the Eastman group.

CHAPTER XIV

CONCLUSIONS AND THEIR IMPLICATIONS FOR EDUCATION

Summary of Conclusions

It would seem fair to claim that the present investigation, within its limited scope, has provided evidence of some genetic factor or factors in musical ability, as measured by the Wing tests. The results from the two parts of the main investigation which suggest such a conclusion are as follows:

1. A clear, definite, if narrow, contrast was found between the mean intra-pair differences and the intra-pair correlations for 20 pairs of MZ and 20 pairs of DZ child twins. This was true both when all the Musical Quotients were calculated from the results on Wing tests 1-3 (MQ II) and when actual scores were used when the marks for tests 4-7 exceeded the level of chance (MQ I). This was true when the groups were enlarged by the addition of 8 adult MZ twins and 9 unlike-sexed child and 3 adult DZ twins. (However, the correlation for the MZ adults alone was .483 and the men's mean MQ II intra-pair differences relatively large).

2. Correlations of up to .475 were obtained between the Musical Quotients of parents and children and a correlation of .496 with a small group of siblings.

Admittedly, this evidence is rather weaker than the results obtained from studies of the general mental ability of twins and of parents and children. But many of the twins were well below average in musical ability. This may have affected the results. On the other hand, many of the parents were well above average and the children were high in musical talent. From such a homogenous group depressed correlations are likely to be obtained.

When the present results are viewed in the light of previous research, the argument in favour of the heredity side would seem to be strengthened. For example, when the evident lack of effect of musical training on the Wing tests is taken into account, it seems reasonable to interpret the association of the children's and parents' musical activity with the children's musical ability as being largely due to hereditary, rather than, environmental factors. It is not, however, suggested that musical ability cannot be modified by experience. The possibility of improving musical ability, as measured by the Wing tests, might be suggested by the difference of 20 marks found between two twins brought up apart (see p. 369). But this difference occurred where one twin had enjoyed the opportunity of training up to piano teaching standard.

Two findings of the investigation were unexpected:

1. The high correlation between the MQs of the fathers and their children and of the male twins; and

2. The considerable difference in the heritability of pitch (as measured by Wing test 2) compared with memory (as measured by test 3).

The correlation of .627 found between fat er and child for the 25 cases where both parents were tested was much higher than that between mother and child. The difference could not be accounted for by the questionnaire data on amount of playing, music lessons or listening to music. In fact, even for children of grammar-school age, the mother, rather than the father, appeared to set the musical environment. Since the numbers were small, the difference might have been thought to be due to sampling errors or to some selection effect. However, a similar sex difference was apparent in the twin results. The highest intra-pair correlation (.899) was obtained with 10 MZ boy twins and the highest heredity index, .617, occurred when they were compared with 9 DZ boy twins. The intra-pair correlation of the MZ girls was similar to that for the DZ girls. It might be argued that the boys had departed less from their initial capacity than the girls. because they had had less opportunity to learn to play and less encouragement to take an interest in music. If tested as adults, their musical ability, having undergone little change through interaction with the environment, would then tend to show a higher correlation with their offspring than would their wive's. Any such hypothesis did not seem to be true for two reasons:

a) as in the case of the fathers, environmental factors, in so far as they could be assessed by the questionnaire data, did not seem to account for the sex difference; and

b) even if it were true that the boy twins had failed to rise above their initial low capacity through indifference or a lack of opportunity, a similar remark would not apply to the fathers. Many of the fathers had considerable experience of music and were as musically active as their wives.

There may be some connection between the higher correlation among the boys and the higher proportion of boys classified as tone-deaf. The male does seem to be more vulnerable to many directly hereditary diseases and defects (see Scheinfeld, 1956, p.176). But further research is required into why only some cases of tone-deafness appear to be resistant to training.

It is difficult to understand how a sex-linked genetic mechanism could be involved in the transmission of musical aptitude when boys and girls make roughly equal scores on musical ability tests. But future research workers might well find it worthwhile considering their results for the sexes separately, to see if the difference found by the writer could be verified or disproved.

Since the Wing pitch test usually correlates highly with the memory test, it is rather surprising that the two tests apparently differ appreciably in the extent to which they may be under hereditary control. As some measure of pitch discrimination would appear to be a precondition of melodic memory (Cf. Chapter II, p.96), one might have supposed that, if any difference existed, the pitch test would show the higher degree of heritability. The difference found with the present results is even greater than Vandenberg's (see Chapter VII, p. 192). The h^2 index for memory was .532, compared with Vandenberg's .42. An attempt to calculate an index for pitch would have produced a negative value, since the DZ correlation was higher than the MZ. Vandenberg used a different statistic to calculate his h^2 indices. Use of the same formula would have increased the present h^2 for memory to .642. Although the results appear to confirm those obtained by Vandenberg with older and more musical children, they should be treated with great caution because of the possibility of the sub-test results being unreliable with subjects of low musical ability. As mentioned in Chapter VII, the results obtained by Rife and by Mjoen suggest that pitch discrimination may be at least partly innate.

The following were the main conclusions from other results obtained from subsidiary parts of the investig tion:

1. The low correlations calculated between the Wing scores of 200 R.M.S.M. junior musicians and their performance of the tests of the Admiralty battery appeared to confirm that musical ability is largely specific. The association between their Wing scores and their socio-economic environment was not statistically significant. There was a moderate positive relationship between their interest in music as a hobby and their Wing scores.

2. The Wing test scores from five groups of subjects were separately factorized. A broad first factor accounted for from 26% to 36% of the variance, the loadings being most consistently and significantly positive in the case of the most musical group. It seemed reasonable to regard this factor as a general factor of musical ability.

Educational Implications

The main conclusion from the previous work in this field and from the present investigation is that there is an important genetic component in musical ability which may set an upper limit to achievement and speed of learning. Tests such as Wing's can be extremely useful aids to assessing the range of the individual's talent. It may not matter too much if such tests are entirely "culture-free", i.e. if to some extent they do measure how well the child has made use of his past opportunities. No doubt the results should be interpreted in the light of the child's previous experience of music in order to estimate whether or not his ability is already functioning near its upper limit.

A most important question is "What can an individual with an MQ of x points achieve?" As Farnsworth (1958, p. 248) suggested, there is need to "study more intensively the minimum levels necessary for later success in several kinds of musical skills".

How far an individual should be advised to spend time on music depends on his musical ability and interest compared with whatever other abilities and interests he may possess.

The writer would agree with Wing that two classes of pupil deserve special attention to their musical education:
a) children with a high level of talent to whom musical studies can bring much enjoyment and perhaps provide a career;
b) those of low general ability who have some aptitude for music. (See Wing, 1948, p.74; and 1955).

Although musical ability appears to be largely specific, music might nevertheless particularly for children whose musical aptitude surpasses their verbal ability, become a path into the wider avenue of Western, or indeed of world, culture. There seems less need since the development of other media of communication (radio and TV) for quite so much emphasis to be placed on the written word as in the past. A music-centred education could be as valuable as one centred on language and literature. For instance, the Elizabethan Age could be approached through the music of Byrd and the madrigalists as well as through Shakespeare and the dramatists. "Team spirit", in so far as it can be "taught", could be instilled as well in the orchestra as on the playing field. As Wing pointed out (1941a, p.414), "music requires habits of concentration, patience, hard work and determination which are equal to those required for any subject".

There might seem to be some danger of creating a musical elite. However, this should not happen if the music teacher can encourage children to feel that the development of their talents may bring enjoyment to other people as well as themselves. It may not be too great an exaggeration to say that musicians, perhaps more than other artists, have tended to show readiness to acknowledge their talents as "gifts of God" to be devoted to the service of their art and not directed towards unworthy ends.

In any case, classifying children according to how far they are likely to profit from opportunities for special lessons should obviously not mean rigidly dividing the gifted from the ungifted. The average children are important if only because there are more of them. The highly talented will find all the greater scope for their skill as performers if there is a musically educated population of listeners. Although the child who is keen to learn may achieve more than one who is superior in the continuum of aptitude but less willing to work hard, a large number of children will have neither the talent nor the wish to do more than singing at at school and listening to music.

In the words of the Scottish Education Department Report (1960) it is "important to realise that the songs which are learned in school may be the only music which the majority of children will experience as performers". But if children can find pleasure and interest in singing at school, they may as adults gain considerable satisfaction from joining a choir.

With so much music being broadcast, it seems particularly important that the schools should try to help their pupils to discriminate between the good and the bad. It may sometimes be necessary e.g. with adolescents to accept their love of "Pop" music and use this as a base from which "to educate their emotions" - i.e. to aim "to refine their taste, not necessarily to alter it" (Rowe, 1959, p.119). Rowe permitted children to bring their favourite records to play during the lunch-hour on condition they would also listen to records chosen by members of the staff. As a result of helping to organise the Gramophone Club, of joining a school harmonica group and of building guitars and a double bass, two of Rowe's pupils became considerably more co-operative and interested in their school work. As Wing (1955) said: "To the dull boy, his one talent may be of very great value in the development of his personality". The kind of activity Rowe describes may not be music teaching in the orthodox sense, but he also recognises the school's responsibility to help the children's taste to grow by presenting them "with examples of good art that they would otherwise not have had the chance of experiencing". Dale (1936) stressed the importance of selecting music not too far removed from the children's understanding. Such music, if not immediately enjoyed, may come to be appreciated, if repeated till it becomes familiar.

The case for providing remedial training in schools for monotones may seem less strong than making provision for those with speech defects or for backward readers. While it may be true that: "A little individual attention usually produces rapid improvement in sense of pitch and control of the voice" (Min. of Educ. Pamphlet, No. 27), some cases may need prolonged and intensive training (see Chapter VIII). In some schools it might be thought worthwhile to organise special classes for monotones. Experiments with e.g. teaching machines might eventually reduce the cost of such work. (Teaching machines may, of course, have uses for training higher levels of musical talent. (Cf. Ihrke, 1963)).

It is particularly important for Primary school teachers to be able to sing, even when there are music specialists on the staff. Many who are not monotones in the sense of being unable to sing in unison with others may not be good models for their pupils, because they may tend to stray from just intonation when singing on their own. Training Colleges might be suitable places for research into how far pitch deficiencies and other musical weaknesses can be remedied by suitable training. Testing and retesting with musical ability tests would provide information as to whether or not musical ability could be improved by such training.

Standardised Tests of Musical Intelligence

H. D. WING,
Principal, City Training College, Sheffield

Name . . . .

Age years .. months. Date .... Sex

Address .. ..

1. Place a **X** against the word that most nearly describes your general attitude towards music.

A. Very interested C. Indifferent . . .

B. Interested . ..... D. Dislike .

You may add — or to the class if you desire finer shades of division than those given.

Does anyone at home play an instrument? If so, state who they are, what they play, and roughly how much. E.g., Father, violin, frequently. Use the terms 'frequently' very often , 'occasionally' now and then), or 'seldom' (hardly ever), to describe the amount of playing when answering this and the following questions.

Do you play yourself? If so, how much? .

If so, which instrument? .

Have you had any lessons? If so, state roughly for h w many years

Do you now ever play f r your own pleasure?

NOT TO BE FILLED IN

TOTAL SCORE GRADE .. MUSICAL AGE

MUSICAL QUOTIENT

Edition V, 1961

Test 3. *Memory.* (*Detecting an alteration of note in a short melody*)

A tune is played twice. On the second playing one note, not more, may be altered. The first four tunes are of three notes, the next four tunes have four notes, and so on, getting longer towards the end. The number of notes is shown by the number of dots in the answer places. See whether you can say which note is altered. The altered note may be shown by marking through the dot which is written for the note in the answer place. Suppose, for example, that the second note of No. 5 is altered it would be shown like this No. 5 ● ϕ ● ● (1 2 3 4) or if it were the fourth note, like this No. 5 ● ● ● ϕ (1 2 3 4)

If the two tunes are the same write S; if they appear different but you do not know which one is altered, do not leave a blank but guess.

Practice: A ● ● ϕ (1 2 3) B ● ϕ ● (1 2 3) C ● ● ● ● ϕ ● (1 2 3 4 5 6)

Answers:

3-note tunes.

1 ● ● ● (1 2 3) 2 ● ● ● (1 2 3) 3 ● ● ● (1 2 3) 4 ● ● ● (1 2 3)

4-note tunes

5 ● ● ● ● (1 2 3 4) 6 ● ● ● ● (1 2 3 4) 7 ● ● ● ● (1 2 3 4) 8 ● ● ● ● (1 2 3 4)

5-note tunes

9 ● ● ● ● ● (1 2 3 4 5) 10 ● ● ● ● ● (1 2 3 4 5) 11 ● ● ● ● ● (1 2 3 4 5) 12 ● ● ● ● ● (1 2 3 4 5)

6-note tunes

13 ● ● ● ● ● ● (1 2 3 4 5 6) 14 ● ● ● ● ● ● (1 2 3 4 5 6) 15 ● ● ● ● ● ● (1 2 3 4 5 6)

16 ● ● ● ● ● ● (1 2 3 4 5 6)

7-note tunes

17 ● ● ● ● ● ● ● (1 2 3 4 5 6 7) 18 ● ● ● ● ● ● ● (1 2 3 4 5 6 7)

19 ● ● ● ● ● ● ● (1 2 3 4 5 6 7) 20 ● ● ● ● ● ● ● (1 2 3 4 5 6 7)

8-note tunes

21 ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8)

22 ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8) 23 ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8) 24 ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8)

9-note tunes

25 ● ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8 9) 26 ● ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8 9) 27 ● ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8 9)

10-note tunes

28 ● ● ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8 9 10) 29 ● ● ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8 9 10) 30 ● ● ● ● ● ● ● ● ● ● (1 2 3 4 5 6 7 8 9 10)

APPENDIX IIa

QUESTIONNAIRE FOR PARENTS

Name.....................Mr/Mrs   No. of children...........

Names of child(ren) at this school at present................

If your wife (or husband) is not present at this meeting, would you please try to answer questions 1 to 8 on her/his behalf as well as your own.

	Own	Wife/Husband
1. What is your general attitude to music? (Underline one answer)	V.interested Interested Indifferent Dislike	V.interested Interested Indifferent Dislike
2. Do either of you play a musical instrument? If so, which instrument(s)?		
How often, on average, do you play when the child at this school is at home e.g. one hour per week?		
How often do you think you played when the child was younger (say 2-5 yrs. old)?		
3. Have either of you had music lessons? If so, on which instrument(s)?		
For roughly how many years and at what age?		
4. Do either of you belong to a choir, orchestra or other musicmaking group? (Give details)		
5. How often in a year do you go to performances of: "classical" music" opera ballet other music e.g. jazz		

APPENDIX IIa (contd.)

---

6. If you have a gramophone, about how often (e.g. one hour per week) do you play records of:
   - "classical" music
   - opera
   - ballet
   - other music e.g. jazz

---

7. How often do you listen to music on the radio or TV when you are not reading, talking or doing something else?

   What style of music do you chiefly listen to?

---

8. Do you ever engage in other musical activities not mentioned above e.g. composing, adult education classes? (Give details)

---

9. Does anyone else in your home play? If so, give details

---

10. Do any of your children other than those at this school have music lessons or show a strong interest in music?

APPENDIX IIa (contd.)

Musical Knowledge Questions

1. Which of the following was written by Handel?
   The Mikado   Messiah   Swan Lake   Blue Danube   Ave Maria

2. Which of these was a famous composer of piano music?
   Strauss   Beecham   Handel   Gilbert   Chopin

3. Which of these instruments would you find among the wood-wind in an orchestra?
   timpani   French horn   oboe   'cello   tuba

4. In which of these is there a famous song about a bull-fight?
   Figaro   Carmen   Tannhauser   La Boheme   Il Trovatore

5. The orchestra was at its most rudimentary stage of development at the time of:
   Mendelssohn   Beethoven   Wagner   Handel   Liszt

6. Which of these instruments usually plays sounds that are highest in pitch?
   'cello   viola   trumpet   flute   piccolo

7. Njinsky was famous as a:
   ballet dancer   violinist   artist   pianist   tenor

8. If these singers are arranged in order of pitch, which falls in the middle?
   baritone   tenor   soprano   contralto   bass

9. Which of these musicians belongs to the early 19th century?
   Bach   Mozart   Brahms   Schubert   Scarlatti

10. The composer of the 'Classical Symphony' is:
    Beethoven   Prokofief   Shostakovitch   Bach   Mozart

11. Which of the following keys has 5 sharps in its signature?
    A   B   C   D   E

12. Which of these pairs of musical compositions are very much alike in form, number of movements etc.?
    Aria and Recitative   Minuet and Rondo
    Suite and String Quartet   Sonata and Symphony
    Concerto and Tone Poem

APPENDIX IIb

QUESTIONNAIRE FOR CHILDREN

Name.................. Age........ Years....... Months .....

---

1. What is your general attitude to music? (Underline one answer)	Very interested Interested Indifferent Dislike

---

2. Do you play a musical instrument? ______________________

   If so, which instrument(s)? ______________________

   About how often do you play e.g. one hour per week?

---

3. Have you ever had music lessons? ______________________

   If so, on which instrument(s)? ______________________

   For roughly how many years and at what age?

---

4. Do you belong to a choir, orchestra or other music-making group? (Give details)

---

5. How often in a year do you go to performances of:
   - "classical" music
   - opera
   - ballet
   - other music e.g. jazz

---

6. If you have a gramophone, about how often (e.g. one hour per week) do you play records of:
   - "classical" music
   - opera
   - ballet
   - other music e.g. jazz

APPENDIX IIb (contd.)

---

7. How often do you listen to music on the radio or TV when you are not reading, talking or doing something else?

   What style of music do you chiefly listen to?

---

8. Do you ever engage in other musical activities not mentioned above e.g. composing, appreciation classes outside school hours? (Give details)

   Have you ever done so?

---

9. Does anyone else in your home play? (Give details)

Musical Knowledge Questions

Same as for parents

APPENDIX III

DISTRIBUTIONS OF SCORES (PARENTS-CHILDREN)

Musical Quotients

MQ	Children
60.9	2
70.9	3
80.9	3
90.9	7
100.9	8
110.9	3
120.9	4
130.9	5
140.9	8
150.9	12
160.9	3
170.9	3
180.9	1
190.9	4
200.9	0
210.9	0
220.9	1
n.	67

Mean 132.820
Median 137

MQ	Parents
55.64	2
65.74	4
75.84	8
85.94	10
95.104	11
105.114	7
115.124	13
125.134	7
135.144	8
145.154	4
155.164	2
165.174	2
n.	78

Mean 111.525
Median 110.7

Both Parents Present

MQ	Children
70.9	1
80.9	0
90.9	7
100.9	5
110.9	1
120.9	0
130.9	1
140.9	3
150.9	8
160.9	2
170.9	1
180.9	1
190.9	3
n.	33

Mean 135.8
Median 145

MQ	Fathers	Mothers
60.9	2	2
70.9	3	3
80.9	2	0
90.9	2	3
100.9	3	5
110.9	6	2
120.9	2	4
130.9	2	4
140.9	2	0
150.9	1	2
n.	25	25

	Fathers	Mothers
Means	107.9	110.3
Median	105	109

APPENDIX III (Contd.)

Children n. = 67

Wing Tests 1-3 (Max.score=80)

Score	Children	Parents
25.9	-	1
30.4	4	3
35.9	2	6
40.4	8	8
45.9	14	18
50.4	7	16
55.9	14	14
60.4	9	9
65.9	6	1
70.4	2	2
75.9	1	-
Mean	53.695	50.830
Median	53.9	50.9

Parents n. = 78

Wing Tests 4-7 (Max.score=56)

Score	Children	Parents
15.9	-	2
20.4	7	8
25.9	20	17
30.4	14	29
35.9	14	15
40.4	11	7
45.9	1	-
Mean	32.875	31.860
Median	32.3	32.1

Musical Knowledge

Score	Children	Parents
2	1	1
3	0	0
4	3	6
5	10	8
6	12	17
7	21	12
8	7	10
9	6	6
10	1	11
11	5	5
12	1	2
Mean	7.015	7.372

APPENDIX III (Contd.)

Listening

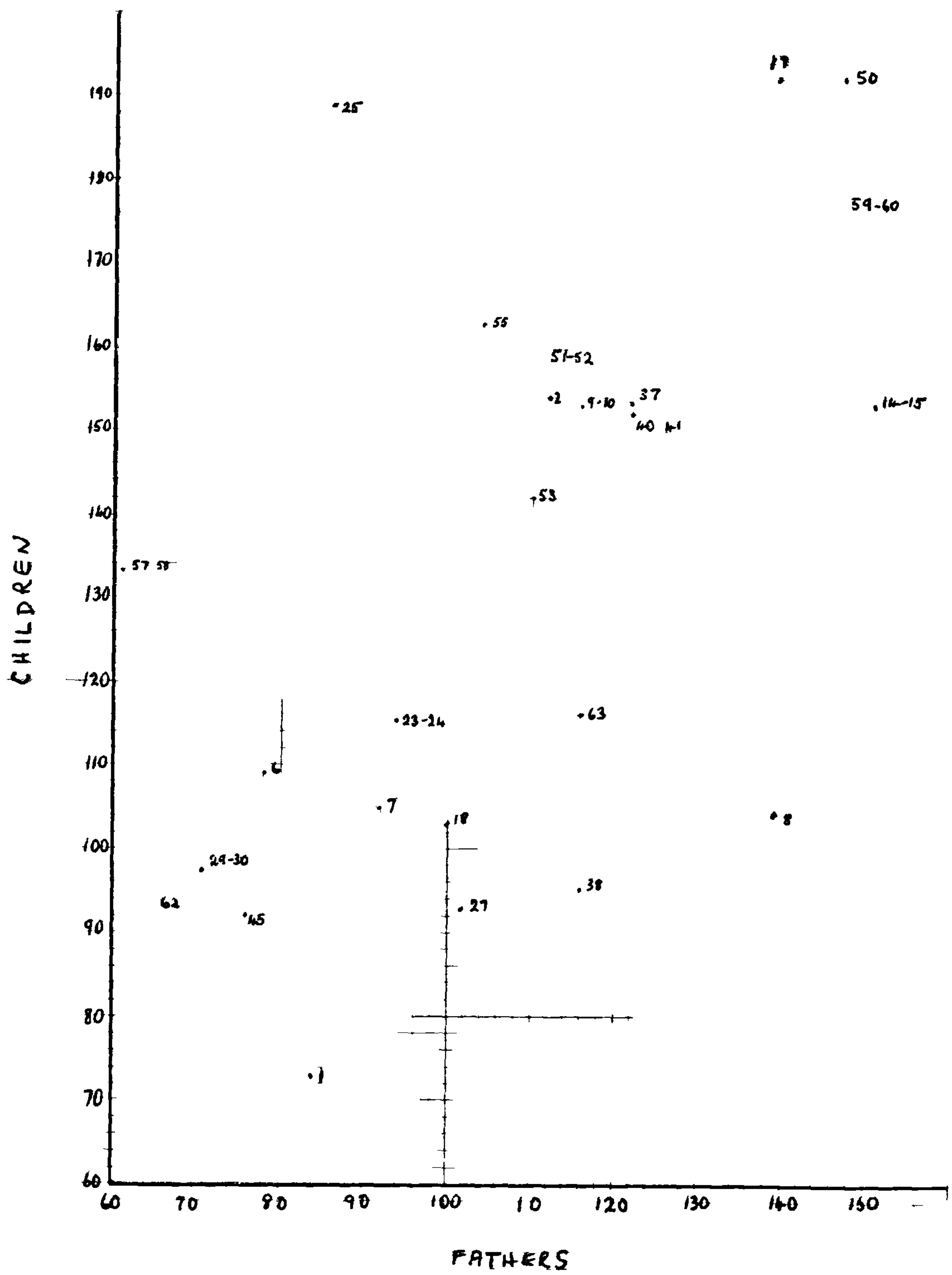
Score	Children	Parents
1	4	6
2	2	5
3	9	11
4	3	7
5	6	14
6	5	4
7	8	5
8	10	6
9	4	1
10	5	4
11	2	7
12	5	4
13	3	4
14	1	-
Means	6.925	6.154

Musical Activity

Scores	Children
0	8
1	9
2	7
3	6
4	7
5	7
6	6
7	6
8	6
9	5
Mean	4.104

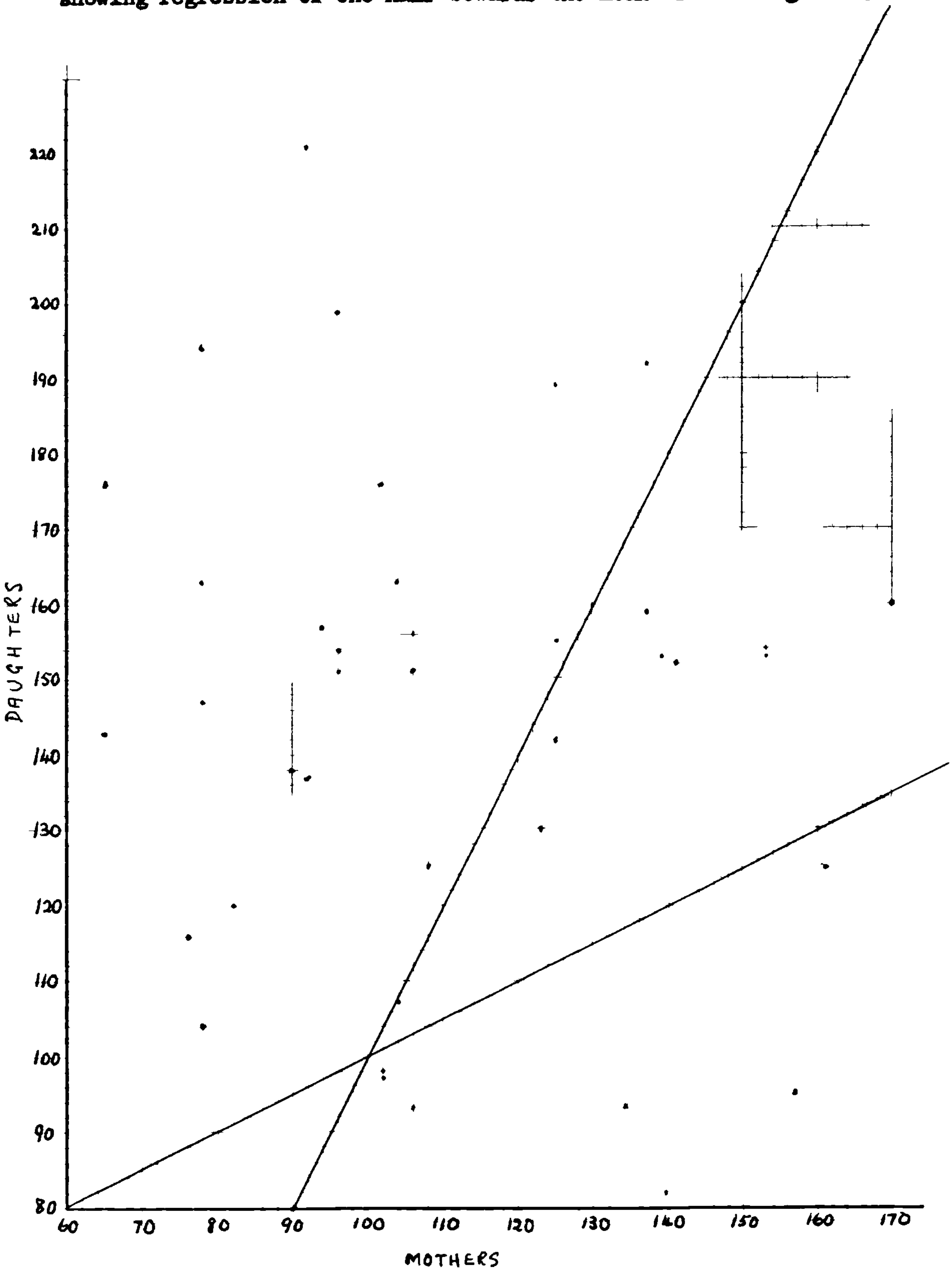
APPENDIX IV

Fig. 1 Fathers' and Children's Musical Quotients. Scores of cases 8, 25, and to some extent 55, show less close agreement between father and child.



APPENDIX IV

Fig. 2 Mothers'and Daughters' Musical Quotients, with lines showing regression of one half towards the mean of the Wing test.



APPENDIX V

CHILD TWIN QUESTIONNAIRE

Name ....

MUSICAL KNOWLEDGE QUESTIONS

Read each question carefully. When you have found the right answer, draw a line under it with a pencil. Do not draw a line under more than one answer to each question.

Example: Which of these instruments would you find among the strings of an orchestra?
oboe <u>violin</u> French horn flute

1. s d' are the first two notes of
   John Peel   Oh where & oh where (The Bluebells of Scotland
   Early one morning   Golden slumbers

2. The highest woman's voice is called
   soprano   bass   tenor   contralto

3. A religious song sung among the negroes of America is called a
   lament   shanty   spiritual   lullaby

4. The "Hallelujah Chorus" is found in
   Elijah   Faust   The Creation   The Messiah

5. Which of these instruments is played by blowing?
   harp   trumpet   drum   viola

6. How many quavers ♪ are equal to a crotchet ♩ ?
   4   8   16   2

7. The key-signature for D major contains
   1 sharp   2 sharps   1 flat   no sharps or flats

8. Which of these famous men was a celebrated composer?
   Be thoven   Nelson   Rubens   Cromwell

9. The dance with the quickest music among the following is a
   Minuet   schottische   pavane   jig

10. Another name for a cradle-song is a
    Seranade   lullaby   round   anthem

CHILD TWIN QUESTIONNAIRE

Q estions 1 - 9 similar to those in Child Q estionnaire of Appendix IIb.

10. What kind of TV programme do you most enjoy?

11. What kind of books do you most like to read?

12. What are your favourite games or sports?

13. Have you ever lived away from home for a long period, e.g. at boarding-school, hospital or staying with relations?

14. When you are with other girls and boys do you usually stay together, or do you go off separately with your own friends?

15. What are some of the ways in which you are different from your twin, e.g. the subjects you prefer at school, or do well, or hobbies?

ADULT TWIN QUESTIO AIRE

Name ....

MUSICAL KNOWLEDGE QUESTIO S

Please underline the answer you think correct.

1. Which of the follo ing w s written by Handel?
   The Mika o   The Messiah   Peer Gynt   Blue Danube   Ave Mari

2. Which of these was a famous composer of piano music?
   Strauss   Beecham   Handel   Sullivan   Chopin

3. Which of these instrume ts wo ld you find among the wood-wind in an orchestra?
   timpani   French horn   oboe   'cello   tuba

4. Which of these contains a famous song about a bull-fight?
   Figaro   Carmen   Tannhauser   La Boheme   Il Trovatore

5. The music for the ballet "Swan Lake" as written by
   Tchaikovsky   Rossini   Berlioz   Weber   Rimsky-Korsakov

6. A religious song sung among the negroes of America is called a
   lament   shanty   spiritual   lullaby   serenade

7. The lowest male voice is called a
   bass   contralto   tenor   soprano   baritone

8. Which of these musicians belongs to the late 19th century?
   Bach   Brahms   Mozart   Schubert   Scarlatti

9. The c mposer of the "Unfinished Symphony" was
   Beethoven   Haydn   Schumann   Mendelssohn   Schubert

10. Which of the following keys has 5 sharps in its signature?
    A   B   C   D   E.

11. Which of these instruments usually plays sounds that are highest in pitch?
    'cello   viola   piccolo   trumpet   flute

12. Which of these pairs of musical compositions are very much alike in form, number of movements etc.?
    Aria and Recitative   Sonata and Symphony   Minuet and Rondo   Suite and String Quartet   Concerto and Tone Poem

TWINS BROUGHT UP APART

Name ....

The following questions refer to your home hen you were a child, say up to the age of 17.

1. Did anyone at home play a musical instrument?
   If so, state who they were, what they played and roughly how much.
   E.g. father, violin, frequently.

2. Did anyone belong to a choir, orchestra or other music-making group? (Give details)

3. How often in a year did you used to go to performances of:
   "classical" music
   opera
   ballet
   other music, e.g. jazz.

4. Roughly what age would you have been when you were first able to listen to a gramophone in your home?
   When you first had a radio at home?

   How often did you listen to music on the radio or gramophone when you were not reading, talking or doing something else?
   At the age of about 12?
   At the age of about 15?

   What style of music did you chiefly listen to?

APPENDIX VI

DISTRIBUTIONS OF TWIN SCORES

Musical Quotients II

	MZ		DZ		
	Children	Adults	Children Like-sexed	Children Mixed	Adults
30.9	3		1	4	1
40.9	6		4	2	1
50.9	5	2	6	2	3
60.9	6	1	5	3	
70.9	7	3	5	2	1
80.9	5	4	3	1	
90.9	3	2	5	3	
100.9	2	2	4		
110.9		2	2	1	
120.9	1		2		
130.9			2		
140.9			1		
150.9			2		
160.9					
170.9	1				
180.9					
190.9	1				
	40	16	42	18	6

Musical Quotients I
(based on tests 1-3)

	MZ Children	MZ Adults	DZ Children Like-sexed	DZ Children Mixed	DZ Adults
30.9	4		1	4	1
40.9	6	2	6	2	1
50.9	5	4	6	3	3
60.9	7	3	7	2	
70.9	9	3	5	2	1
80.9	4	4	4	3	
90.9	1	1	3	2	
100.9	1	1	5		
110.9			3		
120.9	1		2		
130.9	1				
140.9					
150.9	1				
160.9					
170.9					
180.9					
190.9					
	40	16	42	18	6

APPENDIX VII

Table 1

Group 1
Eastman School of Music Students n. = 41

Means		S.Ds.
Test 1	15.756	2.809
2	29.000	1.725
3	25.512	2.131
4	9.927	1.879
5	12.585	1.379
6	10.659	1.734
7	11.439	1.499
Total	114.880	6.783

Correlation matrix

	1	2	3	4	5	6	7	Total
Test 1	1.000							
2	.146	1.000						
3	.412	.232	1.000					
4	.168	.038	.149	1.000				
5	.131	.113	-.102	.214	1.000			
6	.238	.098	.008	.030	.012	1.000		
7	.147	.075	-.032	.055	.017	.302	1.000	
Total	.747	.463	.559	.466	.321	.459	.387	1.000

Principal Components Analysis

Roots			
1	2.7673339,	0	(31)
2	1.2437848,	0	(114)
3	1.1639578,	0	(49)
4	9.3340721,	-1	(48)
5	7.6671143,	-1	(45)

Loadings for 5 Components

Test	1(34.59%)	2 (15.55%)	3(14.55%)	4(11.67%)	5(9.58%)
1	.753	-.115	-.147	-.210	-.407
2	.470	-.152	-.103	.793	.276
3	.569	-.533	-.434	-.119	.039
4	.449	-.212	.520	-.418	.480
5	.296	-.017	.803	.260	-.345
6	.466	.635	-.159	-.032	-.213
7	.388	.690	-.056	-.045	.358
Total	.999	-.001	.031	-.003	.001

Remaining variance 14.06%

APPENDIX VII (contd.)

Table 2

Group 2

Sheffield T.C. Students (Average Group) n. = 100

Means		S.Ds.
Test 1	9.97	2.475
2	20.03	3.299
3	17.61	2.925
4	7.56	1.878
5	8.62	2.194
6	6.86	1.949
7	6.81	1.917
Total	77.48	6.126

Correlation matrix

	1	2	3	4	5	6	7	Total
Test 1	1.000							
2	-.039	1.000						
3	-.033	.171	1.000					
4	-.104	-.095	-.111	1.000				
5	.066	-.025	.095	-.021	1.000			
6	-.034	-.316	-.097	.024	-.008	1.000		
7	.011	-.032	-.010	.060	.087	.092	1.000	
Total	.349	.460	.517	.175	.441	.116	.375	1.000

Principal Components Analysis

Roots			
1	2.04459,	0	(44)
2	1.40600,	0	(71)
3	1.09971,	0	(113)
4	9.80433,	-1	(153)
5	9.02677,	-1	(2)

Loadings for 5 Components

Test	1(25.56%)	2(17.58%)	3(13.75%)	4(12.26%)	5(11.28%)
1	.320	.135	.692	.552	-.064
2	.511	-.609	-.231	.154	-.219
3	.598	-.262	-.048	-.530	.026
4	.029	.354	-.688	.419	.322
5	.500	.258	.174	-.115	.641
6	-.084	.701	.098	-.415	-.181
7	.364	.485	-.221	.094	-.549
Total	.965	.174	-.054	.039	-.030

Remaining variance 19.58%

APPENDIX VII (Contd.)

Table 3

Group 3

National Youth Orchestra n. = 100

Correlation matrix

	1	2	3	4	5	6	7	Total
Test 1	1.00							
2	.14	1.00						
3	.47	.40	1.00					
4	.29	.18	.33	1.00				
5	.42	.20	.30	.19	1.00			
6	.13	.13	.13	.08	.15	1.00		
7	-.09	.00	-.07	.15	.07	-.08	1.00	
Total	.70	.47	.71	.47	.60	.44	.25	1.00

Principal Components Analysis

Roots

1	2.2593410,	0	(36)
2	1.1309708,	0	(55)
3	9.2833275,	-1	(-333)
4	9.1309466,	-1	(102)
5	7.8907072,	-1	(42)

Loadings for 5 components

Test	1(32.28%)	2(16.16%)	3(13.26%)	4(13.04%)	5(11.27%)
1	.728	-.104	-.454	.138	.035
2	.543	-.029	.544	-.495	-.294
3	.778	-.075	-.022	-.303	.056
4	.564	.422	.009	-.037	.619
5	.637	.080	-.212	.363	-.503
6	.324	-.394	.571	.609	.183
7	-.013	.879	.233	.232	-.170

Remaining variance 13.99%

APPENDIX VII (contd.)

Table 4

Group 4

Sheffield T.C. Students: Men   n. = 100

	Means	S.Ds.
Test 1	12.09	2.91
2	24.98	3.26
3	20.54	2.88
4	8.25	2.41
5	9.97	2.30
6	7.67	2.21
7	7.70	1.82
Total	91.05	8.60

Correlation matrix

	1	2	3	4	5	6	7	Total
Test 1	1.00							
2	0.24	1.00						
3	-0.02	.23	1.00					
4	0.05	.08	-.05	1.00				
5	0.31	.37	.31	.08	1.00			
6	0.04	-.20	-.03	.02	-.09	1.00		
7	0.10	.16	.06	.28	.26	.01	1.00	
Total	0.52	.65	.52	.33	.67	.16	.45	1.00

Principal Components Analysis

Roots			
1	2.8390633,	0	(36)
2	1.2375495,	0	(56)
3	1.0680991,	0	(88)
4	9.9440739,	-1	(56)
5	7.1914348,	-1	(69)

Loadings for 5 components

Test	1(35.49%)	2(15.47%)	3(13.35%)	4(12.43%)	5(8.99%)
1	.521	.094	.268	.709	.002
2	.684	-.297	-.197	.146	-.251
3	.490	-.444	.225	-.608	-.106
4	.314	.653	-.401	-.146	-.493
5	.749	-.173	.027	.036	.222
6	-.017	.512	.798	-.173	-.058
7	.496	.469	-.293	-.211	.585
Total	..977	.074	.152	-.052	-.083

Remaining variance 14.27%

APPENDIX VII (contd.)

Group 5 Table 5

Sheffield T.C. Students: Women n. = 100

Means		S.Ds.
Test 1	11.82	2.63
2	23.12	3.55
3	20.53	2.81
4	8.27	1.82
5	10.59	1.85
6	8.69	2.15
7	8.25	2.11
Total	91.25	8.57

Correlation matrix

	1	2	3	4	5	6	7	Total
Test 1	1.00							
2	.20	1.00						
3	.13	.27	1.00					
4	-.00	-.12	.02	1.00				
5	.34	.17	.11	.02	1.00			
6	.28	.25	.15	-.06	.14	1.00		
7	.07	.10	.08	-.05	.04	.15	1.00	
Total	.59	.66	.56	.15	.47	.54	.37	1.00

Principal Components Analysis

Roots			
1	2.8226760,	0	(20)
2	1.1044246,	0	(108)
3	1.0123354,	0	(102)
4	9.4951493,	-1	(44)
5	8.0427053,	-1	(57)
6	6.8512471,	-1	(55)

Loadings for 6 Components

Test	1(35.28%)	2(13.81%)	3(12.65%)	4(11.87%)	5(10.05%)	6(8.56%
1	.630	.280	-.405	.119	.076	-.214
2	.653	-.283	.060	-.359	-.009	.589
3	.540	-.060	.498	-.439	-.175	-.480
4	.021	.767	.545	.194	.184	.207
5	.518	.403	-.428	.028	-.446	.044
6	.590	-.180	-.122	.179	.661	-.119
7	.343	-.394	.291	.737	-.313	.007
Total	.986	.058	.132	.019	-.004	.050

Remaining variance 7.77%

APPENDIX VIII

ROTATION OF FACTORS

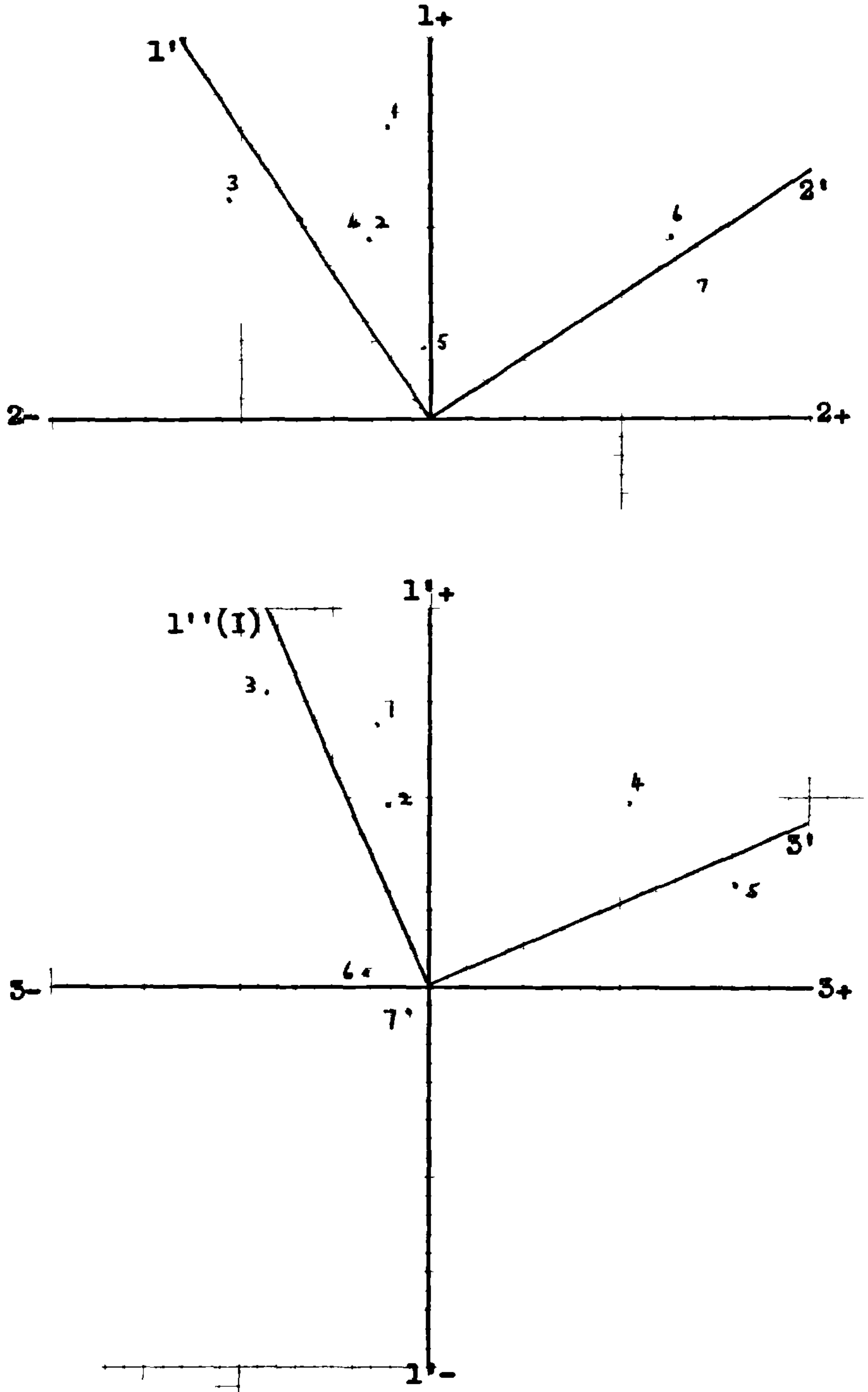


Fig. 1 Group One (Eastman). Rotation of Factor 1 vs. 2 and 1' vs. 3.

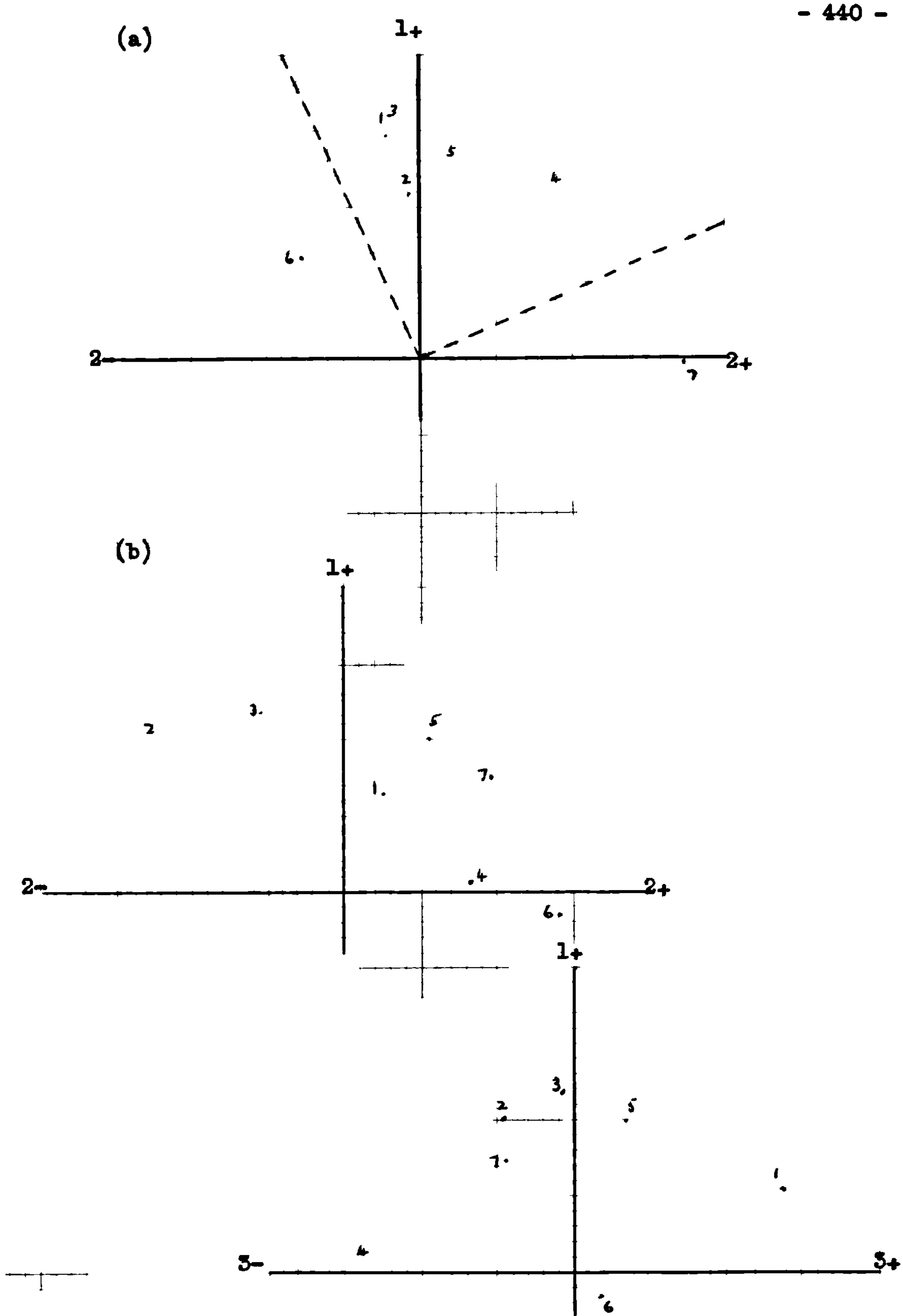


Fig. 2. (a) Group 3 (N.Y.O.) Possible rotation of Factor 1 vs. 2.
(b) Group 2 (Average) Factor 1 plotted against 2 and vs. 3.

APPENDIX IX

ADDENDUM ON HOLMSTROM'S 'MUSICALITY AND PROGNOSIS'

This addendum is intended to draw attention to certain aspects of Holmstrom's work which had not been reported in England when the rest of the present thesis was written.

For his investigation of factors related to success in school music situations, Holmstrom tested over 1,000 children when they were in grade 2 (i.e. aged 8 to 9) and again two years later when they had reached grade 4. As was mentioned on p.85 above, he used a modified version of Wing tests 1 to 3, and a rhythm test. The latter proved rather too easy for the grade 4 children - some 60% scored 26 or more marks out of a possible 30. The reliability coefficients obtained were as follows:

Test	Grade 2	Grade 4
1	.70	.71
2	.86	.85
3	.76	.75
4	.75	.67
Full battery	.91	.90

The validity coefficients were found to be on the .70 level.

Holmstrom adopted school music marks in grades 2 to 7 as the criterion variables for a series of factor analyses, made in accordance with Joreskog's J-method. Besides the music test scores, other variables included : knowledge of music in grade 2, attitude to music as a school subject and to a programme of music in grade 2, attitude to music in grade 7, intelligence and school marks for reading, writing and arithmetic.

In all the analyses, a factor associated with success in the academic subjects and with intelligence was found, but this factor had little connection with success in school music. In general only the music tests and the attitude to music variables seemed to be related to school music marks.

The music tests had loadings in more than one group factor. Holmstrom considered that three types of musical ability group factors were present in his analyses: an Alpha factor, primarily concerned with pitch perception, a Beta factor with loadings particularly in memory, and a Gamma factor with small loadings for intelligence and musical knowledge and interpreted as a general test achievement factor. He thought that the Alpha factor might have a physiological basis and be relatively "environment-resistant", while he described the Beta factor as being an experience of music factor. Holmstrom interpreted the results of his re-analyses of several earlier factorial studies as providing evidence of Alpha and Beta factors, rather than of a general factor of musical ability (Cf. Ch. II above).

One of Holmstrom's reasons for considering the Beta factor as one that reflects experience of music was its lack of prominence in analyses with children from very poor musical environments before grade 4. It may perhaps be true that good pitch perception requires less environmental stimulation for its full development than do other aspects of musical ability, such as memory. However, the Beta type of ability might fundamentally depend as much on innate factors as the Alpha type. Such genetic evidence as is available (see pp.409-410) suggests that the hereditary control of memory is, if anything, rather better established than that of pitch.

In his discussion of the resistance of the Wing tests to experience, Holmstrom cast doubt on the value of Newton's evidence (see p. 260 above), since "That part of the variance due to factors of training was probably exhausted before the boys commenced studying at the RMSM" (Holmstrom, 1963, p. 178). However, out of 223 boys, 120 had less than 2 years musical training, including their terms at the RMSM, and only 24 had a total of more than 5 years musical experience (Newton, 1959, p. 4). No doubt Holmstrom is right to suppose that the boys were likely to have received some positive encouragement from home or school to join the RMSM. The proportion who played or listened to music (see tables on pp.380 and 381 above) is probably much higher than in the general population of adolescent boys. Yet, only 36.5% gave music as their main spare-time interest and 25% did not play at all in their spare-time. (They may, of course, taken part in music-making at school). 15% did not include listening to music among their spare-time activities. It might still be true that, even if they were less sophisticated musically than Holmstrom believed, the junior musicians might have been beyond the stage where intensive study could improve their performance of the Wing tests.

Holmstrom himself contributed the following evidence of the possibility of the tests he used being influenced by environmental factors:

1. Three grade 2 classes practised twice a week for three weeks tasks equivalent to the test material without being told whether their responses were correct. Perhaps due to a lack of motivation, their

performance on retest had improved rather less than had the control group's.

2. The grade 2 and grade 4 results of 47 children who had been playing some instrument between grade 2 and 4 were compared with those of 75 children who had not been receiving lessons. Marked training effects were found for allthe subtests, especially pitch. Holmstrom considered that the improvement might have been still greater if some of the 47 children had not had lessons before the initial test. (He stated that he had other evidence which seemed to suggest that training effects on tests such as he used soon reach a maximum). The average improvement, however, was actually not very great : roughly 10 marks, as compared with 8, out of 164.

3. He compared the test results in grade 2 and 4 of children who came from very good, as opposed to very poor, music home environments. Marked differences in scores were found. These remained significant, even when the attitude to school music and intelligence variables had been eliminated. However, the parents of the children from musically good homes were very likely to be musical themselves (see Chapters VIII and IX above). It is probable that part at least of the differences between the two groups is due to hereditary factors.

To sum up, the writer would agree with Holmstrom on the need for further research into the effects of early music experience on test performance. As suggested on p. 411 above, it is no doubt advisable to interpret the results of music ability tests in the light of the child's previous experience of music. Holmstrom's work confirms the usefulness of such tests in predicting success with school music.

BIBLIOGRAPHY

List A includes works mainly concerned with music or auditory perception or which contain some material of relevance to some aspect of the psychology of music.

The other references cited can be found in List B.

LIST A : MUSICAL

ABRAHAM, G. (1955) This Modern Music 3rd edit. London : Duckworth.

ALFERIS, J. and STECKLEIN, J. E. (1955) "Measurement of Music Achievement at College Entrance," J. Appl. Psychol., 39, 263-272.

ANASTASI, A. (1937) Differential Psychology New York : Macmillan.

ANASTASI, A. (1961) Psychological Testing 2nd edit. New York : Macmillan.

ASHMAN, R. (1952) "The Inheritance of Simple Musical Memory," J. Hered., 43, 51-52.

BAHLE, J. (1934) "Die Gestaltübertragung im vokalen Schaffen zeitgenössischer Komponisten," Arch. ges. Psychol., 91, 444-451.

BEINSTOCK, S. F. (1942) "A Predictive Study of Musical Achievement," J. Genet. Psychol., 61, 135-145.

BELAIEW-EXEMPLARSKY, S. (1926) "Das musikalische Empfinded im Vorschulalter," Zsch. ang. Psychol., 27, 177-216.

BENTLEY, A. (1963) "A Study of some Aspects of Musical Ability amongst Young Children, including those unable to Sing in Tune," Ph. D. thesis, Reading University.

BENTLEY, R. R. (1955) "A Critical Comparison of Certain Musical Aptitude Tests," Doctor's thesis, University of Southern California.

BRENNAN, F. (1926) "The Relation between Musical Capacity and Performance," Psychol. Monogr., 36:1 (Whole No. 167), 190-248.

BRIGGS, L. M. (1938) "A Comparative Study of Children Judged 'Good' and 'Poor' in Singing on the Basis of Past Training in Music and Standardised Music Tests," Master's thesis, Syracuse University.

BRODY, V.A. (1949) "The Emergence of Song," Music Educators J., 36, (Sept.) : 22-4.

BROWN, A. W. (1928) "The Reliability and Validity of the Seashore Tests of Musical Talent," J. Appl. Psychol., 12, 468-476.

BUROS, O. K. (1949) The Third Mental Measurements Yearbook Highland Park, N.J. : Gryphon Press.

BUROS, O. K. (1953) The Fourth Mental Measurements Yearbook Highland Park, N.J. : Gryphon Press.

BUROS, O. K. (1959) The Fifth Mental Measurements Yearbook Highland Park, N.J. : Gryphon Press.

BURROUGHS, G. E. R. and MORRIS, J. N. (1962) "Factors involved in learning a simple musical theme," Brit. J. Educ. Psychol., 32 (1), 18-28.

BURT, C. (1909) "Experimental Tests of General Intelligence," Brit. J. Psychol., 3, 94-177.

BURT, C. et al. (1945) "The Psychology of Art," in How the Mind Works 2nd edit. London : Allen and Unwin.

CAMERON, E. H. (1917) "The Effects of Practice in the Discrimination and Singing of Tones," Psychol. Monogr., 23:3 (Whole No. 100), 159-180.

CAPURSO, A. A. (1934) "The Effect of an Associative Technique in Teaching Pitch and Interval Discrimination," J. Appl. Psychol., 18, 811-818.

CARROLL, H. A. (1932) "A Preliminary Report on a Study of the Inter-relations of Certain Appreciations," J. Educ. Psychol., 23, 505-510.

CHANDLER, A. R. (1934) Beauty and Human Nature New York : Appleton-Century-Crofts.

CHASE, E. (1951) "Kwalwasser-Dykema Scores Earned by Children in the New York State School for Feeble-minded," Thesis, Syracuse University.

CLEAK, R. E. (1958) "A Study of Musical Aptitudes of Children in a Secondary School," Dip. Ed. Thesis, Bristol University.

COFFMAN, A. R. (1949) "Is Rhythm Subject to Training?" Sch. Musician, 21 : 14, 45.

CONNETTE, E. (1941) "The Effect of Practice with Knowledge of Results," J. Educ. Psychol., 32, 523-532.

CORTOT, A. (1935) "Do Infant Prodigies Become Great Musicians?" Music and Letters 16, 2, 124-128.

COULTHARD, J. W. (1952) "An Investigation into Certain Aspects of Oral Ability in French and Musical Ability as Measured by the Wing Test of Musical Intelligence," Ed. B. thesis, Aberdeen University.

COX, C. (1926) Genetic Studies of Genius : Vol. II The Early Mental Traits of Three Huhdred Geniuses Stanford, Calif., : Stanford Univ. Press.

DALE, R. R. (1936) "The Use of Visual and Auditory Aids in the Class Teaching of Music," M. Ed. thesis, Leeds University.

DE GRAFF, L. H. (1924) "The Norms of Sensitiveness to Rhythm," M.A. thesis, Univ. of Iowa.

DOIG, D. (1941-2) "Creative Music", J. Educ. Res., 35, 263-275; 35, 344-355; 36, 241-253.

DRAKE, R. M. (1931) "Tests of Musical Talent," Ph. D. thesis, London University.

DRAKE, R. M. (1933) "Four New Tests of Musical Talent," J. Appl. Psychol., 17, 136-147; "The Validity and Reliability of Tests of Musical Talent," J. Appl. Psychol., 17, 447-458.

DRAKE, R. M. (1939) "Factorial Analysis of Music Tests by the Spearman-Tetrad-Difference Technique," J. Musicol., 1, No. 1, 6-16.

DRAKE, R. M. (1940) "The Relation of Musical Talent to Intelligence and Success at School," J. Musicol., 2, No. 1.

DRAKE, R. M. (1945) "The Effect of Ear Training on Musical Talent Scores," J. Musicol., 4, No. 3, 110-112.

DRAKE, R. M. (1957) Manual for the Drake Musical Aptitude Tests Chicago : Science Research Associates.

DREXLER, E. N. (1938) "A Study of the Development of the Ability to Carry a Melody at the Preschool Level," Child Devel., 9, 319-332.

DRINKWATER, H. (1916) "Inheritance of Artistic and Musical Ability," J. Genet., 5, 229-241.

EDMUNDS, C. B. (1960) "Musical Ability, Intelligence and Attainment of Secondary Modern and E.N.S. Children," Thesis, Leeds University.

EELLS, W. (1933) "Mechanical, Physical and Musical Ability of the Native Races of Alaska," J. Appl. Psychol., 17, 493-506.

EMERSON, L. E. (1906) "The Feeling-Value of Unmusical Tone-Intervals," Harvard Psychol. Stud., 2, 269-274.

FARNSWORTH, P. R. (1928) "The Effects of Nature and Nurture on Musicality," in the 27th Yearbook of the National Society for the Study of Education, Part II, 233-247.

FARNSWORTH, P. R. (1931) "An Historical, Critical and Experimental Study of the Seashore-Kwalwasser Test Battery," Genet. Psychol., Monogr., 9 : 5, 291-393.

FARNSWORTH, P. R. (1934) "Studies in the Psychology of Tone," Genet. Psychol. Monogr., 15:1, 1-91.

FARNSWORTH, P. R. (1958) The Social Psychology of Music New York : Dryden Press.

FARNSWORTH, P. R. (1961) "The Use and Abuse of Music Talent Tests," Amer. String Teacher, 11 (2), 5-6.

FAULDS, B. (1959) "The Perception of Pitch in Music," Princeton University, Princeton, New Jersey.

FEIS, O. (1910) Studien über die Genealogie und Psychologie der Musikers Wiesbaden : Bergmann.

FIELDHOUSE, A. E. (1937) "A Study of Backwardness in Singing among School Children," Ph. D. thesis, London University.

FORBES, H. S. and FORBES, H. B. (1927) "Fetal Sense Reaction : Hearing," J. Comp. Psychol., 7, 353-355.

FRACKER, G. C. and HOWARD, V. M. (1928) "Correlation between Intelligence and Musical Talent," Psychol. Monogr., 39, 2, No. 178, 157.

FRANKLIN, E. (1956) Tonality as a Basis for the Study of Musical Talent Goteberg : Gumperts Forlag.

FRIEND, R. (1939) "Influences of Heredity and Musical Environment on the Scores of Kindergarten Children on the Seashore Measures of Musical Ability," J. Appl. Psychol., 23, 347-357.

FRY, D. (1948) "An Experimental Study of Tone Deafness," Speech, 12 (1), 4-11.

FULLER, J. and THOMPSON, W. R. (1960) Behavior Genetics New York : Wiley.

GALTON, F. (1869) Hereditary Genius London : Macmillan.

GIORDANO, A. and GULI, E. (1960) "Contributo allo Studio dell' Ereditarieta dell' attitudine alla Musica," Arch. Psicol. Neurol. Psichiat., 21, 271-286

GORDON, E. (1961) "A Study to Determine the Effects of Training and Practice on Drake Musical Aptitude Test Scores," J. Res. in Music Educ., 9 (1), 63-74.

GORDON, K. (1917) "Some Tests on the Memorising of Musical Themes," J. Exp. Psychol., 2, 93-99.

GRAVES, W. S. (1947) "Factors Associated with Children's Taking Music Lessons, Including some Parent-Child Relationships," J. Genet. Psychol., 70, 65-89 and 91-125.

GROVE, G. (1954) Dictionary of Music and Musicians 5th edit. ed. Eric Blom.

GUILFORD, J. P. (1957) "Creative Abilities in the Arts," Psychol. Rev., 64, 110-118.

HAECKER, V. and ZIEHEN, T. (1922) Zur Vererbung und Entwicklung der Musikalischen Begabung.

HALLER, M. W. (1932) "The Reactions to Changes in the Intensity and Pitch of Pure Tones," J. Genet. Psychol., 40, 162-180.

HATTWICK, M. S. and WILLIAMS, H. M. (1935) "The Measurement of Musical Development," Univ. Iowa Stud. Child Welfare, 1-100.

HEINLEIN, C. P. (1929) "A New Method of Studying the Rhythmic Responses of Children," J. Genet. Psychol., 36, 205-228.

HENDERSON, M. T. (1951) "Remedial Measures in Motor Rhythm as Applied to Piano Performance," Thesis, Iowa University.

HENDRICKSON, G. (1960) "Music" in Encl. of Educ. Res. 3rd edit. ed. Harris, Macmillan : New York. pp 905-916.

HEVNER, K. (1931) "A Study of Tests for Appreciation of Music," J. Appl. Psychol., 15, 575-583.

HEVNER, K. (1937) "The Aesthetic Experience: a Psychological Description," Psychol. Rev., 44, 245-263.

HEYMANS, G. and WIERSMA, E. "Beitraege zur speziellen Psychologie auf Grund einer Massenuntersuchung," Ges. kleinere Schriften, III.

HIGHSMITH, J. A. (1929) "Selecting Musical Talent," J. Appl. Psychol., 13, 486-493.

HISSEM, I. (1933) "A New Approach to Music for Young Children," Child Devel., 4, 308-317.

HOLLINGWORTH, L. S. (1926) "The Musical Sensitivity of Children Who Test Above 135 I.Q.," J. Educ. Psychol., 17, 95-109.

HOLMES, E. (1845) The Life of Mozart New York : Harper.

HOLMES, J. A. (1954) "Increased Reliabilities, New Keys, and Norms for a Modified Kwalwasser-Dykema Test of Musical Aptitudes," J. Genet. Psychol., 85, 65-73.

HOLMSTROM, L. (1963) Musicality and Prognosis Uppsala : Almqvist and Wiksells.

HOWES, F. (1958) Music and its Meanings Three Lectures delivered in the University of London. London : Athlone.

HURST, C. C. (1912) "Mendelian Heredity in Man," Eugen. Rev. 4 (1), 20-21.

IHRKE, W. R. (1963) "Automated Music Training," J. Res. in Music Education, 11 (1), 3-20.

IL'INA, G. A. (1959) "On the Formation of Musical Conceptions in Preschool Children," Vop. Psikhol., 5 (5), 134-144.

IL'INA, G. A. (1961) "Characteristics of the Development of Musical Rhythm in Children," Vop. Psikhol., 1, 119-132.

JACOBS, C. (1960) "Psychology of Music : Some European Studies," Acta Psychol., 17, 273-297.

JAMIESON, R. P. G. (1951) "An Investigation into Songs Known by Scottish School Children, and their Musical Preferences," Ed. B. thesis, Glasgow University. Summary in Brit. J. Educ. Psychol., 22 (1), 74-75.

JERSILD, A. T. and BIENSTOCK, S. F. (1931) "The Influence of Training on the Vocal Ability of Three-Year-old Children," Child Devel., 2, 272-290.

JERSILD, A. T. and BIENSTOCK, S. F. (1934) "A Study of the Development of Children's Ability to Sing," J. Educ. Psychol., 25, 481-503.

JERSILD, A. T. and BIENSTOCK, S. F. (1935) "The Development of Rhythm in Young Children," Child Devel. Monogr., No. 22, Teachers' College, Columbia.

JOHNSON, G. B. (1928) "Musical Talent of the American Negro," Mus. Superv. J., 15, 81, 83, 96.

KALMUS, H. (1949) "Tune Deafness and its Inheritance," Proc. Int. Cong. Genetics, Stockholm, 605.

KALMUS, H. (1952) "Inherited Sense Defects," Scientific American, 186 (5), 64-70.

KARLIN, J. E. (1941) "Music Ability," Psychometrika, 6, 61-65.

KARLIN, J. E. (1942) "A Factorial Study of Auditory Function," Psychometrika, 7, 251-279.

KLAUER, N. J. (1924) "The Effect of Training in Rhythm upon Rhythmic Discrimination in the Intermediate Grades," State Univ. Iowa, M. A. thesis.

KOCH, H. and MJOEN, F. (1931) "Die Erblichkeit der Musikalität : II Geneostatistische Untersuchungen," Zsch. f. Psychol., 121, 104-136.

KWALWASSER, J. (1955) Exploring the Musical Mind New York : Coleman-Ross.

LAMBERT, C. (1941) "The Relationship between Music-reading Ability, Music Talent and Intelligence," Master's thesis, Syracuse University.

LAMBERT, CONSTANT (1934) "Music Ho! A Study of Music in Decline,"

LANIER, L. H. (1927) "Prediction of the Reliability of Mental Tests and Tests of Special Abilities," J. Exp. Psychol., 10, 69-113.

LAWTON, A. (1933) Foundations of Practical Ear Training Oxford University Press London : Humphrey Milford.

LEHMAN, C. F. (1948) "A Comparative Study of Instrumental Musicians on the Basis of the Kwalwasser-Dykema Music Tests, the Otis Intelligence Test, and the Minnesota Multiphasic Personality Inventory," Doctor's dissertation, Syracuse University.

LEHMAN, C. F. (1950) "A Comparative Study of Instrumental Musicians on the Basis of the Kwalwasser-Dykema Music Tests, the Otis Intelligence Test, and the Minnesota Multiphasic Personality Inventory," J. Educ. Res., 44, 57-6

LENOIRE, Z. (1925) "Racial Differences in Certain Mental and Educational Abilities," Master's thesis, Univ. Iowa.

LEONTIEV, A. N. (1957) "The Nature and Formation of Human Psychic Properties," pp 226-232 in Psychology in the Soviet Union (ed. B. Simon) London : Routledge and Kegan Paul.

LOWERY, H. (1929) "Musical Memory," Brit. J. Psychol., 19, 397-404.

LOWERY, H. (1952) The Background of Music Hutchinson's University Library : London.

LUNDIN, R. W. (1949) "The Development and Validation of a set of Musical Ability Tests," Psychol. Monogr., 63:305, 1-20.

LUNDIN, R. W. (1953) An Objective Psychology of Music New York : Roland Press.

LUNDIN, R. W. (1958) "What next in the Psychology of Musical Measurement?" Psychol. Rec., 8, 1-6.

MC GINNIS, E. M. (1928) "Seashore's Measures of Musical Ability Applied to Children of the Pre-school Age," Amer. J. Psychol., 40, 620-623.

MC LEISH, J. (1950) "The Validation of Seashore's Measures of Musical Talent by Factorial Methods," Brit. J. Psychol.(Stat. Section), 3, 129-140.

MAINWARING, J. (1931) "Experiments in the Analysis of Cognitive Processes in Musical Ability," Brit. J. Educ. Psychol., 1, 182; "Tests of Musical Ability," Brit. J. Educ. Psychol., 1, 313.

MAINWARING, J. (1933) "Kinaesthetic Factors in the Recall of Musical Experience," Brit. J. Psychol., 23, 284-307.

MAINWARING, J. (1947) "The Assessment of Musical Ability," Brit. J. Educ. Psychol., 17, 83-96.

MAINWARING, J. (1948) "Review of H. D. Wing's Tests of Musical Ability and Appreciation," Music and Letters, 29 (3), 290-293.

MAINWARING, J. (1954) "Gestalt Psychology Applied to Music," in Grove's Dictionary of Music and Musicians.

MANOR, H. C. (1950) "A Study in Prognosis," J. Educ. Psychol., 41, 31-50.

MANZER, C. W. and MAROWITZ, S. (1935) "The Performance of a Group of College Students on the Kwalwasser-Dykema Music Tests," J. Appl. Psychol., 19, 331-346.

MEDLEY, A. (1943) "The Introspective Listener," Music and Letters, 24 (3), 171-177.

MILLER, R. (1925) "Über musikalische Begabung und ihre Beziehungen zu sonstigen Anlagen," Zsch. f. Psychol., 97, 191-214.

MINISTRY OF EDUCATION (1960) Teaching Music in the Schools Pamphlet No. 27, H.M.S.O.

MINOGUE, B. (1923) "A Case of Secondary Mental Deficiency with Musical Talent," J. Appl. Psychol., 7, 349-352.

MIZER, C. (1941) "Correlation of Scores Earned by 25 pairs of Twins in Music Talent and Music Achievement Tests," Thesis, Syracuse University.

MJOEN, F. (1925) "Die Bedeutung der Tonhöheunterscheidsempfindlichkeit für die Musikalität und ihr Verhalten bei der Vererbung," Hereditas, 7, 161-188.

MJOEN, J. (1926) "Genius as a Biological Problem," Eugen. Rev., 17, 242-257.

MJOEN, J. (1934) Die Vererbung der musikalischen Begabung Berlin : Alfred Metzner.

MONROE, W. S. (1903) "Tone Perception and Music Interest of Young Children," Ped. Sem., 10, 144-146.

MOORHEAD, G. E. and POND, D. (1941) The Music of Young Children : I Chant Pillsbury Found. Stud.

MOORHEAD, G. E. and POND, D. (1942) The Music of Young Children : II General Observations Pillsbury Found. Stud.

MOORHEAD, G. E., SANDVIK, F. and WIGHT, D. (1951) The Music of Young Children : IV Free Use of Instruments for Musical Growth Pillsbury Found. Stud.

MORROW, R. S. (1938) "An Analysis of the Relations Among Tests of Musical, Artistic and Mechanical Abilities," J. Psychol., 5, 253-263.

MURSELL, J. L. (1932) "Measuring Musical Ability and Achievement : a Study of the Correlation of the Seashore test scores and other variables," J. Educ. Res., 26, 116-126.

MURSELL, J. (1937) The Psychology of Music New York : Norton.

MURSELL, J. and GLENN, M. (1931) The Psychology of School Music Teaching New York : Silver Burdett.

NEWKIRK, V. (1934) "Correlation of Kwalwasser-Dykema Music Tests and Otis Intelligence Tests," Thesis, Syracuse University.

NEWTON, G. de C. (1959) Selection of Junior Musicians for Royal Marine School of Music : An Evaluation of H. D. Wing's Test. Senior Psychologist's Department, Admiralty.

NORTHRUP, W. C. (1931) "The Inheritance of Musical Ability," Stud. Pedigree Studies, Eugen. News, 16.

OAKLEY, J. G. (1946) "A Statistical Study of Scores on the Kwalwasser-Dykema Music Tests by Parents and Their Offspring," Master's thesis, Syracuse University.

OWENS, W. A. and GRIMM, W. (1941) "A Note Regarding Exceptional Musical Ability in a Low-grade Imbecile," J. Educ. Psychol., 32, 636-637.

PANNENBORG, H. J., and W. A. (1915) "Die Psychologie der Musiker," Zsch. f. Psychol., 73, 91-136.

PARTHASARATHY, K. (1957) "Musical Aptitude and Appreciation among High School Students," J. Psychol. Res. (Mysore), 1 (2), 49-59.

PETERSON, J. and LANIER, L. H. (1929) "Studies in the Comparative Abilities of Whites and Negroes," Mental Measurement Monogr., No. 5.

PINKERTON, F. W. (1963) "Talent Tests and Their Application to the Public School Instrumental Music Program," J. Res. in Music Educ., 11 (1), 75-79.

PLATT, H. (1942) "A Survey of Music and Non-music College Freshmen," Master's thesis, Syracuse University.

POLLOCK, T. (1950) "Singing Disability in School Children," M. Ed. thesis, Durham University.

RADLEY, S. (1952) "A Statistical Study Based on a Short Experimental Music Test, Purdue Pegboard Scores and General Intelligence," Master's thesis, Syracuse University.

RESER, H. (1935) "Inheritance of Musical Ability," Student Pedigree Studies, Eugen. News, 20.

REVESZ, G. (1920) "Prüfung der Musikalität," Zsch. f. Psychol., 85, 163-209.

REVESZ, G. (1925) The Psychology of a Musical Prodigy New York : Harcourt Brace.

REVESZ, G. (1946) "Beziehung zwischen mathematischer und musikalischer Begabung," Schweiz. Zsch. f. Psychol., 5.

REVESZ, G. (1953) Introduction to the Psychology of Music London : Longmans Green & Co.

RICHET, G. (1900) "Note sur un cas remarquable de precocite musicale," IV Congress internationale de Psychologie.

RIFE, D. C. and SNYDER, L. H. (1931) "A Ge etic Refutation of the Principles of Behavoristic Psychology," Hum. Biol., 3, 547-559.

ROBERTSON, V. (1941) "The Relationship Existing Between Intelligence and Music Test Scores," Master's thesis, Syracuse University.

ROBINSON, V. and HOLMES, M. E. (1932) "A Comparison of Negroes and Whites in Musical Ability," Thesis, Syracuse University.

ROSS, F. B. (1914) "The Measurement of Time Sense as an Element in the Sense of Rhythm," Psychol., Monogr.,16, 166-172.

RUPP, H. (1915) "Über die Prüfung musikalischer Fähigkeiten," (Teil I) Zsch. ang. sychol., 9, 1-76.

SAKURABAYASHI, H., SATO, Y. and UEHARA, E. (1956) "Auditory Discrimination of the Blind," J. Psychol., Blind, 1, 3-10.

SAKURABAYASHI, H., SATO, Y. and UEHARA, E. (1957) "An Experiment Concerning Learning of Auditory Discrimination of the Blind," J. Psychol., Blind, 2, 45-48.

SALISBURY, F. S. and SMITH, H. R. (1929) "Prognosis of Sight-singing Ability of Normal School Students," J. Appl. Psychol., 13, 425-439.

SANDERSON, H. E. (1933) "Differences in Musical Ability in Children of Different National and Racial Origin," J. Genet. Psychol., 42, 100-120.

SCHEERER, M., ROTHMANN, E. and GOLDSTEIN, K. (1945) "A Case of 'Idiot Savant' : an Experimental Study of Personality Organization," Psychol. Monogr., 58 (4), Pp. 64.

SCHEINFELD, A. (1956) The New Heredity and You London : Chatto Windus.

SCHOEN, M. (1940) The Psychology of Music New York : Roland Press.

SCHÜSSLER, H. (1916) "Das unmusikalische Kind," Zsch. ang. Psychol., 11, 136-166.

SCOTTISH EDUCATION DEPARTMENT (1960) Teaching of Music in Secondary Schools H.M.S.O.

SCRIBER, L. J. (1946) "A Correlation of Kwalwasser-Dykema Scores Earned by Parents and their Children," Master's thesis, Syracuse University.

SEASHORE, C. E. (1919) The Psychology of Musical Talent New York : Silver Burdett.

SEASHORE, C. E. (1938) Psychology of Music New York : Mc Graw Hill.

SEASHORE, C. E., LEWIS, D. and SAETVEIT, J. G. (1960) Manual of Instructions and Interpretations for the Seashore Measures of Musical Talents 2nd Revision New York : The Psychological Corporation.

SEASHORE, C. E. and LING, T. L. (1918) "The Comparative Sensitiveness of Blind and Seeing Persons," Psychol. Monogr., 25, 148-158.

SEASHORE, C. E. and MOUNT, G. H. (1918) "Correlation of Factors in Musical Talent and Training," Psychol. Monogr., 25, 47-92.

SEASHORE, R. H. (1935) "Improvability of Pitch Discrimination," Psychol. Bull., 32, 546.

SEMEONOFF, B. (1940) "Further Developments in a New Approach to the Testing of Musical Ability, with Special Reference to Groups of Secondary School Children," Brit. J. Psychol., 31, 145-161.

SKINNER, B. F. (1963) "B. F. Skinner in Oxford," Bull. Brit. Psychol. Soc., 16, No. 50, 9-11. Reprint of Report, printed in Nature, on the "Future of Teaching Machines".

SMITH, F. O. (1914) "The Effect of Training in Pitch Discrimination," Psychol. Monogr., 17 (3), Whole No. 69, 67-103.

SONTHEIM, C. (1946) "A Study in Inheritance Employing the Kwalwasser-Dykema Tests," Master's thesis, Syracuse University.

STANTON, H. (1922) "Inheritance of Specific Musical Capacities," 31 (1), Whole No. 140, 157-204.

STANTON, H. (1935) "Measurement of Musical Talent: the Eastman Experiment," Univ. Iowa Stud. Psychol. Music, 2, 1-140.

STANTON, H. and KOERTH, W. (1930) "Musical Capacity Measures in Adults Repeated after Musical Education," Univ. Iowa Stud. Aims Prog. Res. 31.

STANTON, H. and KOERTH, W. (1933) "Musical Capacity Measures in Children Repeated after Musical Training," Univ. Iowa Stud. Aims Prog. Res. 42:259.

STREEP, R. (1931) "A Comparison of White and Negro Children in Rhythm and Consonance," J. Appl. Psychol., 15, 53-71.

SWARD, K. (1933) "Jewish Musicality in America," J. Appl. Psychol., 15, 675-712.

SWIFT, F. F. (1939) "A Correlation of Kwalwasser-Dykema Test Scores Earned by Siblings," Master's thesis, Syracuse University.

TAYLOR, E. M. (1941) "A Study of the Prognosis of Musical Talent," J. Exp. Psychol., 10, 1-28.

TAYLOR, I. A. and PAPERTE, F. (1958) "Current Theory and Research in the Effects of Music on Human Behavior," J. Aesth. and Art Crit., 17, 251-256.

TILLIS, M. (1960) Chords and Discords: The Life of an Orchestral Musician London : Phoenix House.

TOMATIS, A. (1953) "L'Oreille Musicale," J. Francais d'Oto-Rhino-Laryngologie, No. 2.

TOMATIS, A. (1953a) La Correction de la Voix Chantee Cours International de Phonologie et de Phoniatrie. March 1953.

TREDGOLD, A. F. (1922) Mental Deficiency (Amentia) 4 edit. London : Bailliere, Tindall and Cox.

TREDGOLD, R. and SODDY, K. (1956) A Textbook of Mental Deficiency 9th edit. London : Bailliere, Tindall and Cox.

UPDEGRAFF, R., HEILEGER, L. and LEARNED, J. (1938) "The Effect of Training upon the Singing Ability and Musical Interest of Three-, Four-, and Five-Year-old Children," Univ. of Iowa Stud. Child Welfare 14, 83-121.

VALENTINE, C.W. (1919) An Introduction to the Psychology of Beauty.

VALENTINE, C.W. (1956) The Normal Child Harmonsworth : Penguin Books.

VALENTINE, C.W. (1962) The Experimental Psychology of Beauty London : Methuen

VAN ALSTYNE, D. and OSBORNE, E. (1937) "Rhythm Responses of Negro and White Children Two to Six," Monogr. Soc. Res. Child Devel., 2, 4.

VANDENBERG, S. G. (1956) "The Hereditary Abilities Study," Eugen. Quart., 3 (2), 94-99.

VANDENBERG, S. G. (1962) "The Hereditary Abilities Study: Hereditary Components in a Psychological Test Battery," Amer. J. Hum. Genet., 14 (2), 220-237.

VATER, H. (1934) "Musikalische Produktion," Arch. ges. Psychol., 90, 1-60.

VERNON, P. E. (1931) "The Psychology of Music with especial reference to its Appreciation, Perception and Composition," Ph. D. dissertation, Cambridge University.

VERNON, P. E. (1934-5) "Auditory Perception: I The Gestalt Approach," Brit. J. Psychol., 25 (2), 123-139; "Auditory Perception: II The Evolutionary Approach," Brit. J. Psychol., 25 (3), 265-281.

VERNON, P. E. (1950) "The Structure of Human Abilities London : Methuen.

VIDOR, M. (1931) Was ist Musikalitat? Munich : Beck.

WALLACE, W. (1914) The Musical Faculty London : Macmillan.

WALTER, BRUNO (1961) Of Music and Music-making trans. Hamburger London : Faber and Faber.

WEAVER, A. T. (1924) "Experimental Studies in Vocal Expression: II The Prediction of Talent for Vocal Expression in Reading," J. Appl. Psychol., 8, 159-186.

WHITLEY, M. T. (1932) "A Comparison of the Seashore and K-D. Tests," Teach. Coll. Rec., 8, 731-751.

WHITTINGTON, R. W. T. (1957) "The Assessment of Potential Musical Ability in Secondary School Children," J. Educ. Psychol., 48, 1-10.

WILLIAMS, E. D., WINTER, L. and WOOD, J. M. (1938) "Tests of Literary Appreciation," Brit.J.EdPsychol., 8, 265-284.

WILLIAMS, J. R. (1952) "The Relationship between Intelligence and Music Scores of Siblings," Master's thesis, Syracuse University.

WING, H. D. (1936) "Tests of Musical Ability in School Children," M.A. thesis, London University.

WING, H. D. (1941) "A Factorial Study of Musical Tests," Brit. J. Psychol., 31, 341-355.

WING, H. D. (1941a) "Musical Ability and Appreciation," Ph. D. thesis, London University.

WING, H. D. (1948) "Tests of Musical Ability and Appreciation," Brit., J. Psychol. Monogr. Suppl., No 27, Pp 88.

WING, H. D. (1954) "Some Applications of Test Results to Education in Music," Brit. J. Educ. Psychol., 24, 161-170.

WING, H. D. (1955) "Musical Aptitude and Intelligence," Education To-day, 5, No 1.

WING, H. D. (1957) "The Measurement of Musical Aptitude," Occup. Psychol., 31, 33-37.

WING, H. D. (1960) Manual for Standardised Tests of Musical Intelligence (City of Sheffield Training College Ref. 600) N.F.Ed.Res.

WING, H. D. (1962) "A Revision of the Wing Musical Aptitude Test," J. Res. in usic Educ., 10 (1), 39-46.

WING, H. D. (1963) "Is Musical Aptitude Innate?" Rev. Psychol. in Music, 1, 1-7.

WITHERSON, M. I. (1935) "The Effect of Race and Nationality on Music Measurement," Master's thesis, Syracuse University.

WOLNER, M. and PYLE, W. H. (1933) "An Experiment in individual Training in Pitch-deficient Children," J. Educ. Psychol., 24, 602-608.

WRIGHT, F. A. (1928) "The Correlation between Achievement and Capacity in music," J. Educ. Res., 17, 50-56.

WYATT, R. F. (1945)"The Improvability of Pitch Discrimination", Psychol., Monogr., 58:267, 1-58.

YATES, N. and BRASH, H. (1941) "An Investigation of Physical and Mental Characteristics of a Pair of Twins Reared Apart from Infancy," Ann. Eugen., 11, 89-101.

LIST B : OTHER

ALLPORT, G. W. (1937) Personality : A Psychological Interpretation New York : Holt.

BLEWETT, D. B. (1954) "An Experimental Study of the Inheritance of Intelligence," J. Ment. Sci., 103, 922-933.

BÜHLER, C. (1935) From Birth to Maturity : An Outline of the Psychological Development of the Child Kegan Paul, Trench, Trubner.

BURT, C. (1943) "Ability and Income," Brit. J. Educ. Psychol., 13, 83-98.

BURTT, H. E. (1932) "An Experimental Study of Early Childhood Memory," J. Genet. Psychol., 40, 287-295.

BURTT, H. E. (1937) "A Further Study of Early Childhood Memory," J. Genet. Psychol., 50, 187-192.

CAMERON, D. E. (1963) "The Processes of Remembering," Brit. J. Psychiat. 109, 325-340.

CARTER, C. O. (1962) Human Heredity Harmondsworth, Middlesex : Penguin Books

CATTELL, R. B. (1950) Personality New York : Mc Graw Hill.

CLARK, P. J. (1956) "The Heritability of Certain Anthropometric Characters as Ascertained from Measurements of Twins," Amer. J. Hum. Genet., 8, 49-54.

CLARKE, C. A. (1962) Genetics forthe Clinician Oxford : Blackwell.

EYSENCK, H. L. and PRELL, D. B. (1951) "The Inheritance of Neurotocism," J. Ment. Sci., 97, 441-465.

GATES, A. I., JERSILD, A. T. et al (1942) Educational Psychology New York : Macmillan.

GESELL, A. and ILG, F. (1943) The Infant and Child in the Culture of To-day London : Hamilton.

HEARNSHAW, L. S. (1951) "Exploring the Intellect," Brit. J. Psychol., 62 315.

HEBB, D. O. (1949) The Organisation of Behavior New York : Wiley.

HILDRETH, G. (1925) "The Resemblance of Siblings in Intelligence and Achievement," Contrib. to Educ., No. 186, Teachers College, Columbia Univ.

JONES, M. C. (1926) "The Development of Early Behavior Patterns in Young Children," Ped. Sem., 33, 537-585.

LUNZER, E. A. (1960) Recent Studies in Britain Based on the Work of Jean Piaget N.F. Ed.Res. Occas. Papers No 4.

MARSHALL, A. G., HUTCHINSON, E. O. and HONISETT, J. (1962) "Heredity in Common Diseases," Brit. Med. J. 1, 1-6.

NEWMAN, H. H., FREEMAN, F. N., and HOLZINGER, K. J. (1937) Twins : A Study of Heredity and Environment Chicago : Univ. of Chicago Press.

PREYER, W. (1892) The Senses and the Will New York : Appleton.

PRONKO, N. H. and BOWLES, J. W. Jr. (1951) Empirical Foundations of Psychology New York : Rinehart.

ROWE, A. W. (1959) The Education of the Average Child London : Harrap.

SCOTTISH COUNCIL FOR RESEARCH IN EDUCATION (1949) The Trend of Scottish Intelligence Univ. of London Press.

SENDEN, von (1960) Space and Sight: The Perception of Space and Shape in the Congenitally Blind Before and After Operation Trans. Heath London.

SHIELDS, J. (1962) Monozygotic Twins Brought Up Apart and Brought Up Together London : Oxford University Press.

SHINN, M. W. (1907) The Development of the Senses in the First Three Years of Childhood Univ. of Calif. Publ. in Educ. Vol. 4.

SHIRLEY, M. M. (1933) The First Two Years: II Intellectual Development Univ. of Minnesota Press.

SHULL, F. (1948) Heredity New York : Mc Graw Hill.

TANNER, J. et al. (1956) Discussions on Child Development :II Proceedings of the Second Meeting of the World Health Organisation Study Group on the Psychobiological Development of the Child. London : Tavistock Publications.

TANNER, J. et al (1960) Discussions on Child Development : IV Proceedings of the Fourth Meeting of the World Health Organisation Study Group on the Psychobiological Development of the Child. London : Tavistock Publications.

TERMAN, L. M. (1947) Psychological Approaches to the Biography of Genius. Occas. Papers on Eugenics o. 4 London : Eugenics Society.

TERMAN, L. M. et al (1925) Genetic Studies of Genius : Vol. I The Mental and Physical Traits of a Thousand Gifted Children. Stanford, Calif. : Stanford Univ. Press.

TORRANCE, E. P. (1960) "Explorations in Creative Thinking," Education, 81, 216-220.

VERNON, M. D. (1960) "The Development in Perception in Children," Educ. Res. 3 (1), 2.

VERNON, P. E. (1960) Intelligence and Attainment Tests London : Univ. London Press.

WALTER, G. GREY (1953) The Living Brain London : Duckworth.

WATSON, J. B. (1930) Behaviorism Rev. Edit. New York : Norton.

WERTHEIMER, M. (1951) "Hebb and Senden on the Role of Learning in Perception," Amer. J. Psychol., 64, 133.

WHITE, R. K. (1931) "The Versatility of Genius," J. Soc. Psychol., 2, 460-489.

WILLIAMS, A. A. (1958) "Number Readiness," Ed. Rev. Inst. of Educ. Univ. of Birmingham, 11, 31-46.

ZUCKERMAN, C. and ROCK, I. (1957) "A Reappraisal of the Roles of Past Experience and Innate Organizing Processes in Visual Perception," Psychol. Bull., 54, 269-296.