THE MEASUREMENT OF MUSICAL TALENT

BY

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The Problem

THE psychology of music is now being built up in the laboratory from three points of view, namely: the psychology of individual talent, the psychology of aesthetic feeling in musical appreciation and expression, and the psychology of the pedagogy of music. Our subject limits this discussion to the first of these three aspects.

Musical talent, like all other talent, is a gift of nature—inherited, not acquired; in so far as a musician has natural ability in music, he has been born with it. Perhaps natural ability of a high order is not so very rare, for modern psychology has demonstrated that a surprisingly small portion of our talents are allowed to develop and to come to fruitage, and thus has given great reinforcement to the dictum that many men "die with all their music in them." From the point of view of measurement, the latent power is as tangible as the developed, and is often of greater interest. The measurement of musical capacity, therefore, concerns itself chiefly with inborn psycho-physic and mental capacities as distinguished from skill acquired in training.

In 1842 the greatest physiologist of that time declared that it would forever remain impossible to measure the speed of the nerve impulse; yet, within two years of that time, his colleague measured it with accuracy. Up to that time it had been supposed that the nerve impulse might have the speed of an electric current; but the measurement showed that it takes a nerve impulse as long to pass from the foot to the brain of a man as it would take the electric current to pass half way around the globe. About the same time it was almost universally believed that "the time of thought" could not be measured; but the "reaction-time experiment" did on the mental side what the measurement of the nerve impulse had done on the physical side. Talent, like the dream, has been thought of as peculiarly illusive and intangible for observation. Yet the science of individual psychology to-day virtually "dissects" the genius, analyzes and measures talents, sets out limitations, diagnoses the possibilities, and directs the development of the individual.

Musical talent is not one thing. To amount to anything, there must be a hierarchy of talents, sufficiently related to work together. Hierarchies of talents may present entirely different organizations in different individuals. The analysis of musical talent aims first to locate the dominant traits and then to determine qualitatively and quantitatively the composition or characteristics of each group, or hierarchy of traits. The term musical talent is therefore used in a collective sense.

It is quite possible to make a fairly exhaustive classification of the essential traits of musical talent. This may be done by considering, first, the characteristics of sound which constitute music and, second, the mental powers which are needed for the appreciation of musical sounds.

The elements of musical sound are really three, namely: pitch, time and intensity. The fourth attribute of sound, extensity, which represents the spatial character, is negligible for the present purpose. Pitch is the quality, the essence of a sound. Timbre, usually spoken of as quality, is merely a pitch complex. Consonance, harmony, and clang fusions are also pitch-complexes. Rhythm represents aspects of time and intensity. This classification of the fundamental aspects of musical sounds gives us a basis for the classification of musical talents into the ability to appreciate and the ability to express respectively, pitch, time, and intensity of tone. Each of these may, of course, be subdivided in great detail.

Turning then to the human side of music, we find that the capacity for the appreciation and expression of music may be divided, for convenience, into four fundamental capacities; namely, sensory, the ability to hear music; motor, the ability to express music; associational, the ability to understand music; and affective, the ability to feel music and express feeling in music. By combining these two classifications—the elements of musical sounds and the capacity of the human individual—we shall obtain the principal groups of musical talent.

Arranging the principal measurements now available in the psychology of music laboratory on the above bases of classification, we get a scheme like the accompanying list of measurements on a singer. Certain modifications of this list would, of course, be necessary in Section II to adapt it to other performers, such as the violinist or the pianist.

List of Measurements on a Singer

- I. Sensory (ability to hear music).
  - A. Pitch.
    1. Discrimination ("musical ear;" tonal hearing).
    2. Survey of register.
    3. Tonal range: (a) upper limit, (b) lower limit.
    4. Timbre (tone color).
    5. Consonance and dissonance (harmony).
  - B. Intensity (loudness).
    1. Sensibility (hearing-ability).
    2. Discrimination (capacity for intellectual use).
  - C. Time.
    1. Sense of time.
    2. Sense of rhythm.
- II. Motor (ability to sing).
  - A. Pitch.
    1. Striking a tone.
    2. Varying a tone.
    3. Singing intervals.
    4. Sustaining a tone.
    5. Registers.
    6. Timbre: (a) purity, (b) richness, (c) mellowness, (d) clearness, (e) flexibility.
    7. Plasticity: curves of learning.
  - B. Intensity.
    1. Natural strength and volume of voice.
    2. Voluntary control.
  - C. Time.
    1. Motor ability.
    2. Transition and attack.
    3. Singing in time.
    4. Singing in rhythm.
- III. Associational (ability to imagine, remember and think in music).
  - A. Imagery.
    1. Type.
    2. Rôle of auditory and motor images.
  - B. Memory.
    1. Memory span.
    2. Retention.
    3. Redintegration.
  - C. Ideation.
    1. Association type and musical content.
    2. Musical grasp.
    3. Creative imagination.
    4. Plasticity: curves of learning.

IV. Affective (ability to feel music).
  A. Likes and dislikes: character of musical appeal.
    1. Pitch, timbre, melody and harmony.
    2. Intensity and volume.
    3. Time and rhythm.
  B. Emotional reaction to music.
  C. Power of æsthetic interpretation in singing.

The writer has outlined elsewhere (Psychology in Daily Life, D. Appelton Co., 1913, Ch. VII.) how each of the measurements in this list may be performed.

An Example of a Measurement

To illustrate the method of proceedure in measurements of this kind as briefly and accurately as possible, we may consider one, as an example, in some detail. The first in the list (IA1) may serve this purpose.

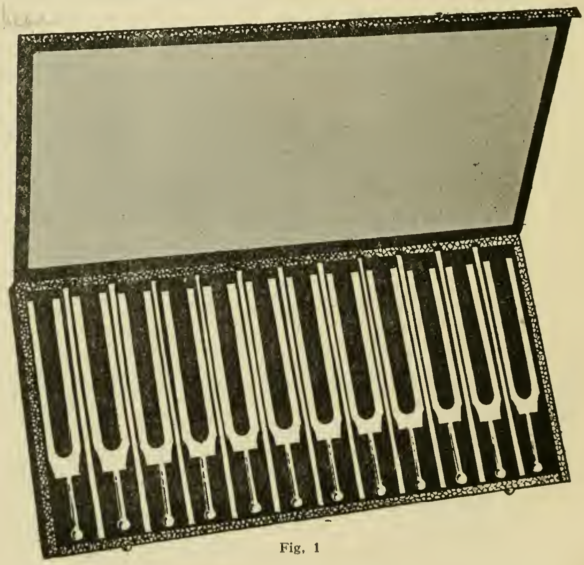


Fig. 1

The first rule of experimental psychology is to reduce the problem so that there shall be only one variable and all other factors shall be kept under relative control. The variable must be measurable, repeatable, and describable. In this test we want to vary and measure pitch. Time, timbre, intensity, sequence-complexes and all other factors of tone must therefore be kept relatively constant or uniform; and all conditions must be kept as simple as possible. The task is merely to hear which of two tones, sounded in rapid succession, is the higher.

This test must be made so simple and elemental that it shall be equally feasible for young and old, for musical and for unmusical. It has proved no small undertaking to devise, test, and standardize, apparatus and methods which shall make these conditions possible. A full account of the standardization of this test has been published by the present writer.[1]

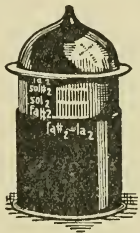


Fig. 2

The apparatus consists of a set of tuning forks, Fig 1, a resonator, Fig. 2, and a rubber covered lead rod to strike the forks upon. The standard fork, which is duplicated, has a pitch of 435 vibrations, a′, international pitch. The remaining forks are tuned higher than this by small increments, as follows:—½, 1, 2, 3, 5, 8, 12, 17, 23, and 30 vibrations, respectively. The resonator is mounted in a convenient position. The forks are sounded by striking gently upon the rod and holding before the resonator. So long as a fork is merely held in the hand it cannot be heard; but the moment it is presented before the mouth of the resonator, it speaks the tone loud and pure. The loudness and the duration of the tone are regulated by the position and the time before the resonator.

The standard and one other fork are sounded in rapid succession and the observer, who is blind-folded, is required to say whether the second tone is higher or lower than the first. A preliminary test is made in which we begin with the largest interval, 30 vibrations, and then take successively the remaining intervals

[1] Psychol. Rev. Monog. (Princeton, N. J.) No. 38, pp. 30-60.

in the order of decreasing magnitude. Repeating this a few times, we soon get an approximate indication of the measure; *e. g.*, on the average, the observer gets all right down to a difference of 5 vibrations. This limit is called the threshold. This approximate threshold being found, we then take a large number of trials, one hundred to five hundred, on a single interval—that one for which the observer, according to the preliminary test, is most likely to get 75 per cent. right judgments. Having found what per cent. of judgments actually are right in the test we convert that by applying a formula which gives the magnitude of the interval that will yield 75 per cent. right judgments. Thus, supposing that in five hundred trials on 3 vibrations we get 78 per cent. right judgments, computation shows that it would take a difference of 2.6 vibrations to yield the required 75 per cent. of right cases with this ability; 2.6 vibrations would therefore be the threshold of pitch discrimination in this case.

This measure may be converted into "part of tone" by recognizing that in this interval a′-b′ one vibration equals one fifty-fourth of a tone; 2.6 vibrations therefore equal about one-twentieth of a tone. The equivalent of vibration-differences in terms of whole-tone differences may be represented as follows:

Vibrations	1/4	1/2	1	2	3	5
Part of tone	1/216	1/108	1/54	1/27	1/18	1/11
Vibrations	8	12	17	23	30	
Part of tone	1/8	1/5	1/3	1/2−	1/2+	

To illustrate further the procedure in the interpretation and the application of records of this kind, let us consider in turn the specific conditions which bear upon the interpretation of this record. In doing this we must keep foremost in mind the first rule of interpretation in applied psychology, namely, that the interpretation shall be limited to the bearing, direct or indirect, of the factor under control, *i, e.*, the factor measured. Here we have measured pitch discrimination, one out of a hundred or more measurable factors in musical capacity, one of the many elements in "the sense of pitch." We must search diligently into the reliability, the qualifications, the meaning, the ramifications, and the practical significance of this measure. But we cannot generalize in regard to musical capacity as a whole on the basis of this measure alone, except as such general capacity is modified by the limitations in the capacity measured.

Individual Differences. It is a matter of common observation that individuals differ in their sense of pitch. In pitch discrimination, stripped of all vagueness and confusion, we have a quantitative measure of the magnitude of this one factor, and can get a clear-cut picture of the distribution of individual differences in this specific capacity.

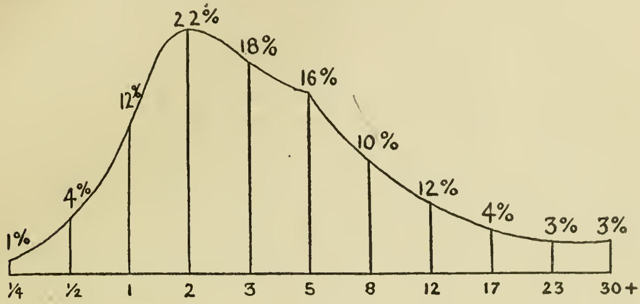


Fig. 3

Fig. 3 shows the normal distribution for university students in a frequency curve which is based on twelve hundred cases. The numbers at the bottom designate the conventional series of steps in terms of vibrations, from 1/4 to 30. The figures on the curve give the per cent. of cases whose threshold of pitch discrimination falls at each of the levels designated by the steps. Thus, 1 per cent. can hear a difference of 1/4 vibration; 4 per cent. can hear a difference of 1/2 vibration; 12 per cent. can hear a difference of 1 vibration, etc. The mode, the most frequent record, is at 2 vibrations. The best measurement is 1/4 vibration, and all but 3 per cent. can hear a half-tone. The average is 2.5 vibrations.

A Norm. This curve of distribution, being based upon a sufficiently large number of representative cases, may be regarded as a norm in terms of which individual and isolated records may be interpreted. For example, if a child is measured and gives a record of .8 vibration, it will be seen by reference to this norm, that this child finds a place among the best, *i. e.*, in a small group of 8 per cent. at the head. If his record were 2.6 per cent. this is found to be near the average ear; whereas, if the record were 15 vibrations, it would be decidedly among the inferior. Such a norm is then a standard by which we may evaluate our individual tonal hearing just as we judge our height or weight in terms of the published anthropometric charts. Indeed the curve is quite similar to a height curve in that the cases tend to bunch about the middle and the number of cases diminishes rapidly toward both extremes. It differs, however, from the height curve in that the units at the bottom are not equal but form approximately a geometric series of the second order. The distribution is therefore said to be skew.

Cognitive v.s. Physiological Limit. It is clear that the threshold as defined above, is an arbitrary standard; and we may fairly ask if it represents a mental or a physiological limit. It is convenient to distinguish between the cognitive threshold and the physiological threshold. The cognitive threshold is a limit which is due to cognitive difficulties such as ignorance, misunderstanding, inattention, lack of application, confusion, objective or subjective disturbances, misleading thought, inhibitions in recording, etc. The physiological threshold is that limit which is set by the character of the physical structure of the pitch-differentiating apparatus in the organ of Corti in the inner ear. A cognitive threshold is really no measure at all; it is merely an indication of the fact that the conditions are not under control and serves as a means of discovering sources of error. A flawless measurement should give the physiological threshold; but that, like all other forms of perfection, is scarcely attainable. We therefore content ourselves with a "proximate physiological" threshold. This is what Fig. 3. represents, and it is the concept we must employ in most practical work. The three chief factors which account for the difference between the physiological and the proximate physiological threshold are,—the convention of counting 75 per cent. of right cases, which is based on the theory of probability; the physiological variation in the organ of Corti with varying body tone; and the failure to eliminate disturbances in the test. It is therefore safe to say that the actual psycho-physical limit is always somewhat lower than the conventional threshold.

Reliability and Success. Since the record is of diagnostic value only when it represents approximately the bed rock of capacity, it is important to have means of determining when and to what extent this is reached. In the first place, we can never get a record that is too good, *i. e.*, below the physiological threshold. An error is always in the direction of a cognitive threshold which must be reduced. In the actual test the experimenter may observe sources of error such as objective disturbances, his own lack of skill, or the subjective difficulties reported by the observer. He must then labor to eliminate them. But, in the last resort, the record itself contains internal evidence in the character of the distribution of the errors by which the expert may know whether or not he has reached the desired limit.

Ordinarily, under favorable conditions, the desired threshold may be established in a single sitting of less than an hour in an individual test. If a task is not satisfactory in the first sitting, it must be repeated until it complies with the required criteria of reliability. Occasionally we find a resistant case which may leave us in doubt after many trials, but in individual work, 95 per cent. of the cases should be disposed of in less than two hours of intensive measurement.

The above norm is based upon the measurement obtained in the second hour of a group test, which is about equivalent to an individual test. It therefore contains cases that are further reducible. A final-test norm would show a considerable improvement in some of the records.

Illusions of Pitch. One very interesting and baffling feature which is encountered in this test is the illusion of pitch. Many of these illusions have been identified, isolated, measured, and expressed in terms of mental law. Among these is the illusion of anticipation, or expectant attention. If one consciously or unconsciously anticipates that the second of two tones in a small interval is to be the higher and it really is the higher, the difference will seem greater than it really is; but if, on the other hand, it is really lower, there are two possibilities: if it is relatively little lower, it will still be heard as higher, whereas, if it is distinctly lower, it will be heard as lower and the interval will be overestimated. Similar to this are the illusions due to the differences in the intensity, the timbre, the pitch level, the location, etc., of the tones. All such errors must be eliminated. It would be no test at all merely to ask the observer if he heard a difference, as the early experimenters did; he must be required also to give the direction. By virtue of the illusions we often tend to hear two tones of the same pitch as different and sometimes feel a higher degree of certainty in a judgment which is wrong.

Absolute Pitch. We hear much about the possession of "absolute pitch." It would perhaps, be facetious to say that some persons come into my laboratory at the State University of Iowa with absolute pitch, but no one has yet been known to leave with it, which is the truth. Some musicians can of course identify any key sounded on the piano in isolation; but the claims of absolute pitch go beyond that, as *e. g.*, when the violinist says that the violin string sounded by itself first thing in the morning is one vibration below international pitch. Often, indeed, he can tell this, not by absolute pitch, but by memory of conditions of tuning, by difference in timbre, and by a happy guess, etc. In this way many musicians cultivate fixed illusions of absolute pitch. The claims about absolute pitch when referring to such small differences, exist only so long as they are not checked by actual measurement.

To measure absolute pitch, let the experiment run for some months, devoting a minute or two to the test each day, in the morning before any other musical sounds are heard, as follows:—Use the above set of forks, Fig. 1, with the resonator producing pure tones. Sound the standard on the first day until it is thoroughly familiar. On the second day sound one fork—either the standard or a differential fork—and require the observer to say whether this tone is standard or a higher tone. Then sound the standard in preparation for the next day. Repeat this procedure on successive days until each of the differential forks has been sounded at least ten times. The record will then show what is the smallest pitch difference that can be heard without error when the compared tones are a day apart.

We are here concerned with the relative pitch. It is common that a violinist may have a pitch discrimination of 1/2 vibration but it would be an extraordinary and improbable case that he should have an absolute pitch to the extent of 5 vibrations, or one-tenth as good as the relative pitch hearing.

Tone-Deafness. It is likewise generally supposed that tone deafness is a common occurence. There is of course a great variety of cases of tone deafness on record in clinical otology and aphasia. There are many possible causes, both in physical and mental pathology. From the point of view of the "normal" community, it is of interest to note that Smith (Psychol. Rev. Monog. (Princeton, N. J.) No. 69, pp. 69-103) in measuring 1980 school children, taking every child in a given room without exception, did not find a single case of tone deafness. Many cases were resistive; but, through his skill and ingenuity, he was able to show that in this entire number there was no one who could not hear as small difference as a whole tone. Tone-ignorance is sometimes appalling, but we must distinguish between that and tone deafness. Taking this fact with the above observations on absolute pitch, we find that common opinion is extravagant, both in ascribing achievement and in denying capacities.

Practice. As a result of an extensive study of the effect of practice on 467 school children and 54 university students, Smith (*op. cit.*) arrived at the following conclusions:

> The sensitiveness of the ear to pitch difference can not be improved appreciably by practice. There is no evidence of any improvement in sensitiveness to pitch as a result of practice. When a person shows a cognitive threshold practice ordinarily results in a clearing up of the difficulties which lie in the way of a true measure of discrimination, by information, observations, a development of interest, isolation of the problems in hand, and more consistent application to the task in hand. This is, of course, not improvement in the psycho-physic ear but merely a preliminary to a fair determination of the psycho-physic limit.
>
> Training in pitch discrimination is not like the acquisition of skill, as in learning to read or to hear overtones. It is in the last analysis informational and the improvement is immediate in proportion to the effectiveness of the instructions or the ingenuity of the observer and the experimenter in isolating the difficulty.

In this respect the limit of pitch hearing is like the limit of acuity of vision. As training in the use of the eye does not improve the dioptric system of the eye so that one may see finer print or greater distance; so practice does not modify the actual structure of the organ of Corti in the ear so as to make it more responsive to pitch, except in the sense that a violin may be improved by use. But, as the ability to give meaning to what is seen—the ability to use the eye to its limit—is amenable to training and finds its limits of development only in the limits of the grasp of memory, imagination, thought, feeling, and will; so the meaning of pitch, in all its intricate operations, is capable of refinement through training, and passes gradually from a simple sensory impression, in one direction, into fixed automatisms and, in the other direction, into conscious analysis and synthesis.

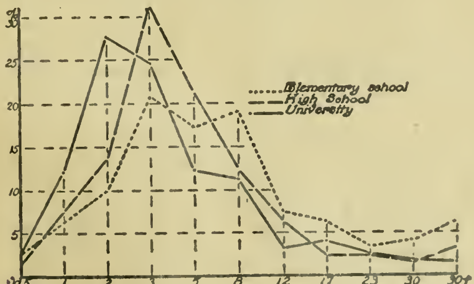


Fig. 4

Age. The actual psycho-physic capacity for pitch discrimination does not improve with age, *i. e.*, with general mental growth. Some children are ignorant, obstinate, and helpless in a test of this kind. This is likely to fall off with age in childhood. Fig. 4., shows the distribution of records in a single group test in each of three ages. The records of the younger children are slightly inferior to those of the older, but this is amply accounted for by the presence of conditions for observation among the younger children, which are ordinarily overcome as experience grows with age. These conditions are, however, merely disturbances in the measurement; they would not ordinarily operate in the child's hearing of music. We often find the finest record in children of five to ten years of age, who have had no musical training whatever. Three out of four of the writer's children equalled the record of their father's ability, which is good, each one before the age of five and without any musical training. Reliable measurement may be made upon children as early as three to four years of age, depending upon the natural brightness of the child. If we measure a hundred children, intellectually at an age capable of observation, and measure also the mothers of these children, it is probable that the records of the children, will average as high as the records of their mothers. Aside from selection, the same principle would apply to teachers and their pupils.

Sex. The capacity for pitch discrimination does not vary appreciably with sex. Records of school girls are ordinarily superior to the records of school boys, but this is due to the common aloofness of the preadolescent boy toward music. The boys in the American schools investigated, often regard music as a frill for girls and therefore do not enter the test with the same zeal and fervor as do the girls. It is significant that this difference in favor of girls disappears at the university age notwithstanding the fact that there is still more interest in music among young women and they have, on the whole, had more advantages of musical training than the university men.

Elemental nature of the Test. This test is elemental in the sense that, when applied under favorable conditions, it calls forth a relatively simple and immediate sensory act which is so single and isolated that the performance of it does not improve with practice. This was a goal in the designing of the test and the extent to which it is successful has been discussed under the head of practice. In so far as we deal with a cognitive threshold, this test is not elemental; it becomes elemental only as we approach the physiological threshold. In its elemental nature this test contrasts with complex processes in musical hearing, such as the hearing of overtones, the analysis of chords, judgment of timbre, all of which require training.

Basal Nature of the Test. This test is basal in the sense that many other aspects of musical capacity rest upon the capacity here measured. Thus, tonal memory, tonal imagery, the perception of timbre, singing and playing in true pitch; and to a certain extent, the perception of harmony, and the objective response are limited by any limitation that may be set in pitch discrimination. If the pitch discrimination is poor, we can predict, at least, a corresponding inferiority in the derived factors. On the other hand, excellence of pitch discrimination does not necessarily insure excellence in these factors, since it is only one element in them. There are six such basal measurements—three sensory and three motor; one on pitch, one on intensity, and one on time, for the sensory side and for the motor side respectively.

Theory. No physiological theory of pitch discrimination is fully established. We know that the pitch differentiating mechanism is located in the organ of Corti in the inner ear and that it works on mechanical principles in the selection of vibrations which determine pitch. It is safe to say that ordinarily variations in capacity for pitch discrimination are due to variations in the sensitiveness of the selecting mechanism. It is natural to suppose that this should vary in individuals just as height and color vary within large limits.

Intelligence. The test of pitch discrimination is not an intelligence test. A person may be a philosopher, a mathematician or an inventor, and yet have "no ear for music." Preliminary tests as a rule, show that the brighter persons on the whole tend to make a better record, but this is because all the "good observers" are able to give a reliable test in the first trial whereas the dull, the careless, and the backward blunder at first and give only a cognitive test, which must be further reduced before it can be accepted.

Inheritance. There is no doubt but that musical talent may be inherited, but there are no reliable statistical data on the subject, although there is much biographical material. The first condition for statistics is that the facts under consideration shall be identified and measured. This we have only recently learned to accomplish. The fact that Smith (*op. cit.*) when comparing the records of children in the same family with children in different families, in a group of 1980 children, found no tendency for records within a family to agree more closely than records among unrelated families, should sound a warning and incite cautiousness in the accepting of biographical material in naive form. It shows the necessity, as well as the possibility, of including specific measures in extensive studies of inheritance.

Tonal Range. This measure was taken at 435 vibrations because that is approximately in the middle, the most stable, the most used and the most sensitive part of the tonal range. Sounds may give the character of tonality to the human ear as low down as 12 vibrations and possibly as high as 50000 vibrations, although the upper limit varies greatly with individuals. But pitch discrimination is defective near both these ends. It does not vary uniformly throughout as the constant part of a tone, *e. g.*, 1/50 of a tone, nor with the absolute vibration frequency, *e. g.*, 1 vibration at all levels of pitch; it is a sort of irregular combination between these two tendencies, as is shown in Fig. 5 by Vance (Psychol. Rev. Monog. No. 69, pp. 115-149). Since this curve is a fair representation for all normal persons, a measure at one level, such as we have here at 435 vibrations, gives also a serviceable knowledge of the relative sensitiveness at other levels.

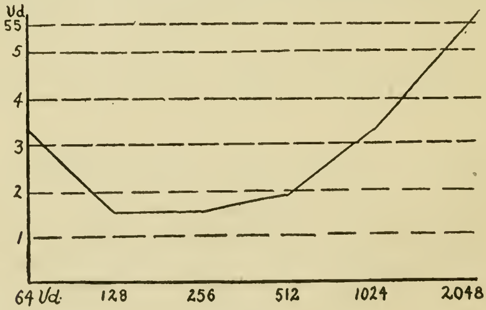


Fig. 5

Evaluation. Fourteen years ago the writer proposed the following tentative evaluation for the purpose of vocational guidance (Ed. Rev. Vol. XXII, pp. 69,82.); and, in the extensive use of the test since then, he has seen no serious reason for changing it:

Below 3 vd.: May become a musician;
3-8 vd.: Should have a plain musical education (singing in school may be obligatory);

9-17 vd.: Should have a plain education in music only if special inclination for some kind of music is shown (singing in school should be optional);
18 and above: Should have nothing to do with music.

This account of procedure in one of the numerous tests under consideration is perhaps sufficiently generic to serve as a general illustration of measurements in musical capacity, in particular those included in the above list. Each test presents an individual problem, often requires its own peculiar apparatus and technique, results in its own norms and its own laws of behavior for the factor under control, and requires its own interpretation. Each problem having been dealt with in isolation, the next step is to collate the results and interpret each one in the light of every other record of talent.

The Talent Chart

For the purpose of illustration we may now assume that each of the tests listed above have been made and evaluated in the spirit and on the plan of the given example. How shall we then bring such a mass of material into a single picture, into graspable form and relief?

The first step is to reduce all numerical records to a sort of common denominator. This may be done by what we may call the method of percental rank. In one case the record may be in terms of vibration, in another in terms of time, in another in terms of number of successes, etc. A direct comparison of values would be bewildering for want of a common unit; but the method of percental rank furnishes such a unit.

When a norm like Fig. 3., has been established on adequate data, we may transform the data on which that norm is based into percental rank values. For the sake of simplicity, let us assume that the data represent only one hundred cases. In this method we woúld rank the best 100 per cent, the poorest 1 per cent, and the remaining ninety-eight between these limits in the order of magnitude of the record. From the data back of Fig. 3., we may then construct a table which gives the percental rank value of each of the units employed, as follows:

% rank		vibrations	% rank		vibrations
100	—	.25	50	—	2.5
95	—	.5	45	—	2.8
90	—	.7	40	—	3.1
85	—	.9	35	—	3.5

% rank		vibrations	% rank		vibrations
80	—	1.1	30	—	4.6
75	—	1.3	25	—	5.2
70	—	1.6	20	—	7.1
65	—	1.8	15	—	9.1
60	—	2.0	10	—	12.0
55	—	2.2	5	—	18.5

For each and all measurements in the above list on which we have sufficient data, those data may be set out in a table of percental ranks like this. The advantage is clear. If, *e. g.*, a pupil stands 92 per cent. in pitch discrimination, 18 per cent. in the sense of rhythm, 72 per cent. in auditory imagery, etc., the meaning is perfectly definite and clear at a glance; all records are presented in terms of the same unit, percental rank.

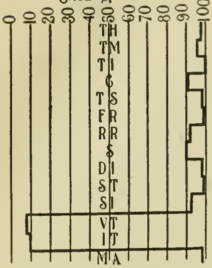
We may go one step further and picture the results of all measurements in a single graph or curve, which shall show a sort of profile of features, a single sketch of a persons' musical talent at a glance, when familiar with the plan. Six such charts are shown in the accompanying illustration.

These charts are made to cover only those measurements on which we have adequate norms at the present time. The initials with numbers in parenthesis refer to the tests in the lists as follows:

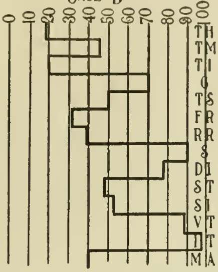
T. H. (IA1)	Tonal hearing, or pitch discrimination as described above.
T. I. (IIIA1)	Tonal imagery; the ability to hear in imagination.
T. M. (IIIB1)	Tonal memory; the span of immediate memory for tones.
C. (IA5)	Consonance; the ability to distinguish consonances from dissonances.
T. S. (IC1)	Time sense; the ability to hear with accuracy the duration of short time-intervals.
F. R. (IIC4)	Free rhythm; the ability to mark a free rhythm.
R. R. (IIC4)	Regulated rhythm; the ability to follow a set rhythm.
S. S. (IB1)	Sensitiveness to sound; "hearing-ability."
D. I. (IB2)	Discrimination for the intensity of sound.
S. T. (IIA1)	Singing a tone in true pitch.
V. T.	Vocal training } based on a systematic questionnaire.
I. T.	Instrumental training } based on a systematic questionnaire.
M. A.	Musical appreciation } based on a systematic questionnaire.

When the plan of these charts is once familiar and the measurements are known, these graphs form striking pictures which convey to us an immediate representation of the features of musical traits or capacities quite as naturally as a photograph conveys the type of physical features.

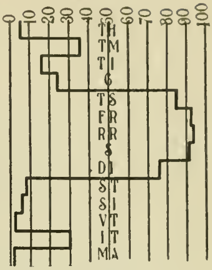
CASE A



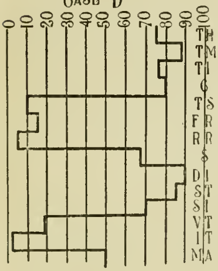
CASE B



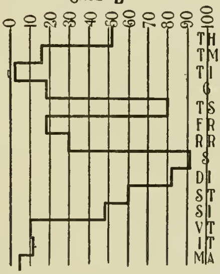
CASE C



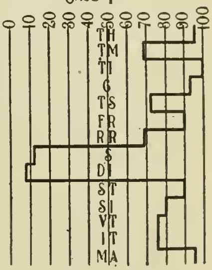
CASE D



CASE E



CASE F



Case A. Extraordinary musical talent. Has had no musical training. Loves good music. Would have been encouraged for a musical career if discovered early enough. Boy age 20.

Case B. Poor musical talent. Has had extensive vocal and instrumental training. Intellectually bright. Advised to discontinue intensive training in music.

Case C. Lack of sense of pitch; hence also poor in tonal imagery, tonal memory, and sense of consonance.

Case D. Lack of time sense. Has good sense of pitch. Beautiful singer aside from time. Intellectually keen. Mingled feelings in regard to appreciation.

Case E. Lack of tonal imagery; hence also memory and rhythm. Good time sense. Intellectually bright. Does not care for music at all.

Case F. Good musical talent. Sensitive musical temperament. Lives in music. Shiftless and poor in other studies.

Meaning and Use

As acquaintance with a person whose photograph one sees gives a life touch to the bare outline of the features suggested on paper, so acquaintance with the system of measurement, biographical and professional knowledge of the individual, and common sense observation arouse through the chart a sense of relationship and a feeling of insight which tend to make the picture realistic and true.

This system of measurements, if it may be called a system, is unfortunately not adapted for general use by musicians themselves. It presupposes a techinque, an equipment, and a skill in psychological analysis which the musician does not possess. It requires a specialist trained in music and psychology and will tend to open a new profession—that of a consulting psychologist in music. Since the elaborate measurements will be made only on those who have serious aspirations for a professional career in music, many will not be needed; but laboratories might well be maintained in a few of the principal music centers.

The function of such a laboratory specialist will be most varied and interesting. His primary business will, of course, be to take inventories of individual capacities for the purpose of vocational guidance of a highly specialized sort. It is no small matter if parents can take a twelve-year old son or daughter into this sort of laboratory and secure a chart of musical talents. The effort and expense of securing such an inventory is insignificant in comparison with the cost of a professional musical education. It is difficult to estimate the value of such an inventory, whether it serves the purpose of encouragement and stimulus of good talent or serves in the saving of one who has serious incapacity for some essential part of the life work which might have been blindly entered. The stake at such a time is not primarily dollars and cents, but human happiness through adaptation to a life work, and a most wholesome advancement of the art.

There will however be more frequent demand for service to the musician who has encountered some serious obstacle. The psychologist will be ready with tests which may be employed in making scientific diagnosis of the obstacle, for to him the human organism is an instrument—a receiving instrument and a producing instrument. He believes in cause and effect, just as the oculist, the aurist and the mechanic of the stalled motor car do. Exactly what is the obstacle? Can it be repaired? Will a substitute do? How serious is it? What is the natural thing to do? The discovery and isolation of the cause of the trouble is the first logical step toward the discovery of a remedy. We see the coming of a new specialist. He will have a mission.

This inventory also serves to explain experiences of the past which may not have been understood. If the singer has had defeat, it will show exactly why. If she has been misguided in musical training, it may show the nature of the error and its results. If the singer is conscious of lack in some capacity, the record shows the nature of this lack, and may even suggest a remedy, if such there is. Even among the best musicians it is rare to find one who does not have some kind of difficulty. Indeed, the difficulties of the singer are unquestionably great. If psychological measurement can lend assistance by laying bare the conditions of the difficulty and by determining its nature and extent, it will indeed in this respect be a handmaid of music. It may also be of great value in discovering new singers who are not aware of their genuine ability.

Another effect of such measurements is not only to objectify the elements of musical appreciation and expression so as to deepen the insight of the expert, the teacher, and the pupil, but also to shape the science and art of music as the scientific conceptions gradually become known. The measurements will furnish an outline for the psychology of music. (Psychology in Daily Life, p. 220)

There is, however, also a place for the measurement of musical talent outside of the laboratory. A few of the tests may be made informally in the conservatory. The principle of measurement may be adapted to the needs of teaching, not merely for diagnosis, but also as a means of training. In singing, correction of pitch, timbre, time, etc., can be made most effectively if the pupil practices with an instrument which reveals to the eye of the singer the exact fault or merit of each tone produced. The tonoscope, (Psychol. Rev. Monog. No. 69, pp. 1-18) *e. g.*, reveals to the eye of the singer the actual pitch of the voice to a hundredth of a tone on the principle of moving pictures, and the pupil trains his voice by his eye. The tone-analysis does the same for timbre. It throws on the screen a picture of the distribution of overtones. The time sense apparatus (Psychol. Rev. Monog. No. 69, pp. 166-172) does the same for time. It shows in detailed graphic record on a ticker tape the rhythm as sung.

But there is a far larger field, in the elementary schools. Certain of the few most fundamental tests can and will be used as as group tests, for the purpose of a rough preliminary sifting in the schoolroom. This will reveal the unusually bad as well as the unusually good; and both of these classes deserve individual treatment. Such tests may eliminate the helplessly unmusical and save them from an intolerable imposition of musical requirements; but their real value is in finding the gold in the dross. One gifted child found early, investigated, and encouraged, is a great reward.

It is also fortunate that this principle may be utilized in devising drill exercises in music instruction. By isolating the elements of music and presenting feature after feature to the class, the elements of musical sounds and elements of human musical talents may be made clear for the purpose of rendering training conscious and specific.

In brief, talent has been a sort of mysterious puzzle to teacher and pupil just as the stars were to ancient man. The mystery has not been cleared or made simple; but scientific psychology has given us an approach, a tool, a vision. This in no way dispels the art attitude, but rather enhances it. The mere artist views talent as we view the starlit heavens on a moonlight stroll; the one who begins to control conditions, to employ instruments, and to apply scientific principles (inductive and deductive) and measures, views human talents as the astronomer views the heavenly bodies. The astronomer magnifies distances, intensifies illuminations, analyzes the atmospheres, reviews the records of ages, trusts his instruments and gives wings to scientific imagination; he measures, predicts, and explains; and with it all his visible universe grows larger, more orderly, and more sublime. He brings order out of chaos, breaks the mad spell of those believing themselves to be under their fateful influences, and sets aglow the imagination of those who love the stars. The expert in the measurement of human talents has similar opportunities. The stars form a macrocosm; the powers of the human mind are a microcosm. Both are orderly. Astronomy is old; the science of the human mind is barely coming into existence. The psychology of music is a new field, quite unworked, but full of promise and fascinating possibilities. Knowledge of self comes after knowledge of things, but is none the less valuable and interesting. Applied knowledge of self comes later still. In the survey of natural resources characteristic of the conservation movement of the day, the survey of natural resources in the shape of human talents is most promising.