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ABSTRACT

This report offers some general principles which are helpful for designing and constructing a test for measuring musical aptitude of persons from various age groups. A discussion attempts to clarify the concepts used within the psychology of music. The basic structuralist principles favored by Gestalt psychologists and structuralists are also discussed. The report suggests that many abilities measured by musical aptitude tests are effects of musical experience rather than musical aptitude. The concepts discussed--creative musicality, musical memory, musical intelligence, the sense of tonality, the sense of rhythm, and the sense of harmony--can be tested for their consistency with musical behavior, their circularity, and their importance. The report indicates that there are seldom clear and simple answers to the questions about the domains of constructs in the psychology of music. The structuralist tradition in music psychology, which maintains that most of the meaning in music is its structure, stresses the following properties in any test of musical aptitude: (1) the test must measure the ability to conceive groups of relations; (2) the relations must be objective; (3) the relations must be relatively general; and (4) the items must be constructed so that there are substructures in them. Problem areas of research in musical aptitude are identified. (Author/DB)

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3. Theoretical refinements

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1. Some general principles and their relevance to the concept of musical aptitude

1.1. Concepts and their use

1.1.1. General

A concept is an abstraction formed by thinking; it consists of the properties essentially alike in a group of beings. These properties together form the contents of the concept. All beings having these properties form the domain of the concept. Concepts may be called classes of experience: "One necessary condition for the formation of a concept is that the individual must have a series of experiences that are in one or more respects similar; the constellation of 'respects' in which they are similar constitutes the 'concept' that underlies them" (Carroll 1970 a, 219). A concept may also be called a rule: "When someone learns a concept, without exception, what he has learned is a rule, a rule of language, or more generally, a rule of behavior" (Green 1968, 28).

Concepts are not only formed by thinking; they also make it possible to think reasonably; "concepts are the vehicles of thought" (Harré 1966, 3). Without concepts it would not be possible to comprehend the world and communicate: every single being would be new without the frame of reference of belonging to a class of beings, the common properties of which are already known.

The domains of concepts are not the same in all languages and cultures. What is considered the domain of a concept is mainly a matter of practicality and efficiency. In a certain culture or environment, the best concept is the one

that gives possibilities for the most efficient operating; the concepts used by the inhabitant of a jungle differ from those the inhabitant of a city uses; a scientist's language differs from that of a layman, and so on. According to the "linguistic relativity hypothesis" the concepts learned by someone have an essential effect on how he thinks (Carroll 1970 b, 178, Whorf 1970, 68, Lloyd 1972, 36, Bernstein 1973).

Many concepts are such that instances of them cannot be directly shown to exist. In such a case the concept is hypothetically constructed so that it explains the observed facts, i.e. it may be considered the cause for happenings on the operational level. These concepts are usually called constructs.

Although difficult to predict, human behavior (animals are deliberately left aside here) is not completely random. Some people tend to have better success in solving certain problems, some have typical reactions in stress situations and so on. These deviations from randomness are thought to have their causes; these causes are constructs. Typical constructs are, for example, intelligence, honesty, numerical ability.

It should be noted that, being hypothetical, a construct may not have a counterpart in reality or, at least, its closer nature may be totally unknown. Constructs must be continuously modified according to new facts. In other words, there must be an interaction between constructs and phenomena on the operational level. According to Nunnally (1967, 98): "Ideally, one could envision a process whereby gradual refinements of a set of observables would be matched by gradual refinements of the words used to denote the set. Thus relatively inexact terms like 'anxiety' and 'intelligence' would be successively replaced by terms that were more denotatively exact for a set of observables,

the set itself being continually refined in terms of an internal structure and a cross-structure with other sets of variables."

Two opposite trends may be found in the construct-forming of the behavioral sciences: the tendency to find as wide and general constructs as possible and, on the other hand, attempts to find the most spesific constructs corresponding to very limited areas of behavior. The former trend tries to find efficient and economic rules or principles which make it possible to explain behavior with the minimum of constructs while the latter tries to find as many elements or primary traits as it is possible to separate from each other. A combination of these two may lead to a hierarchical structure of constructs, such as the hierarchical structure of human abilities (eg. Vernon 1961, Smith 1964, 25).

Being concepts, constructs are more or less arbitrary agreements and can not be said to be true or not true; however, they may be better or worse. Good constructs must be in accordance with known facts and also explain them. These properties are in close interaction and thus cannot always be separated from each other.

It has been said earlier that "explaining" means that constructs may be thought of as causes of happenings on the operational level. Being causes, constructs must have the following properties:

a) In general, a construct must make it easier to comprehend the world and to act in it, ie. it must be useful. It does this by stating what is common in seemingly different phenomena but also by stating what is different in seemingly similar things. The construct of gravity is said to be efficient because it relates seemingly very different things: the falling of objects and the orbiting of planets.

A good construct uses essential similarities and differences instead of superficial ones. What is essential depends on what the construct is used for.

b) A construct must reduce facts to something different from its operational counterparts. If the construct is synonymous with the facts to be explained it is circular and explains nothing. An exaggerated example of a circular explanation would be the following: "X drives bicycle well because ha has a good bicycle-driving ability". The ability is said to exist because X has been observed to drive well and good driving is said to exist because of the ability. The circularity of this explanation is clear but there are instances where it is very difficult to detect. When someone´s success in tests is explained by saying that he is intelligent, the intelligence must involve something else than success in tests. Success in tests may be used as an operational definition which serves as an estimate of intelligence but is not the construct itself. Not to be circular the construct "intelligence" must imply something else than the operations eg. at least a hypothetical possibility of being reduced to the microstructure or the chemical composition of the brain.

c) Because a construct is considered to be a cause of what happens on the operational level it (or, properly speaking, an instance of it in any single case) must exist earlier in time. If intelligence is said to explain school achievement it must have existed before the observed achievement, if someone hits another person "because of certain attitudes" the attitudes must have existed before the hitting. To return to the bicycle example: sensory-motor co-ordination would be a real explanation. It has existed before the person in question had learned to drive a bicycle, "bicycle-driving ability" has existed only simultaneously with the operation: good driving.

How much a construct is in accordance with known facts can be only partially empirically tested. Within the behavioral sciences this is most often done on the basis of statistical principles: properties which appear systematically in a representative sample of people are thought to be "naturally" related if this relation cannot be explained with some superficial or external causes. By systematical appearance is meant that the properties tend to appear in the same persons or, vice versa in different persons more than statistical randomness would permit. In practice, variations of correlational techniques and significance testing are most often used to find these relations. Here the word "correlation" is used widely to refer to any statistical relation and it consists of both of the above mentioned techniques.

Correlations very seldom "prove" anything where the domains of constructs are concerned. Usually, they simply make some interpretations more likely to reflect reality than others. Therefore the process of construct-forming cannot be mechanical, there is always some subjective reasoning involved. There are, however, some rules which seem inevitable:

1) If a researcher wants to keep certain phenomena separate he must be able to show that their correlation is not complete; ie. there must be some cases where the phenomena in question actually are separate. There may, for example, be cases of brain injury where the patient loses a very limited ability usually always appearing in connection with some other abilities. This may be considered a proof that these abilities are functionally separate.

2) If a researcher wants to consider certain phenomena operational counterparts of a given construct he must

be able to show that they correlate. Presence of correlation does not imply a construct, however, it just makes it possible. Thus, for example, factor analysis can only give hints about which variables may be considered parts of a construct, it does not automatically form any constructs.

3) Phenomena which are thought to operationalize a given construct must have, to a certain degree, similar correlation patterns to external variables.

1.1.2. Implications

The purpose of the foregoing discussion has been to give rules for critical viewing of and, if possible, clarification of the concepts used within the psychology of music. There are many terms which seem unnecessary in scientific usage as well as terms and definitions which are vague and explain very little.

It may be reasonable to ask why musical psychology should be so loaded with vague terminology, why not, for example, the psychology of intelligence or personality? Although far from exact, their construct-building seems much less vulnerable to criticism. It is the author's opinion that the linguistic relativity hypothesis may give an answer to this.

Many researchers of musical psychology have a profound schooling in music which tends to make them think in terms of music instead of terms of psychology. It is not always remembered that concepts such as "rhythm", "tonality", and "harmony" are meant to describe music, not musical

aptitude. Consequently, one easily thinks using terms such as "the sense of rhythm", "the sense of tonality", and "the sense of harmory" etc. It is not at all clear, however, that concepts of this kind are the best ones to describe musical aptitude. Certain characteristics in music do not imply corresponding aptitudes in man's mind. It seems reasonable to expect that musical aptitude would be something more abstract and general, perhaps independent of the musical culture one belongs to.

When describing musical behavior writers do not usually specify if the concepts they use are constructs, operational definitions or something in-between. However, they are often used in a way which suggests that they are thought of as constructs. This is the case, for example, when it is said that a test measures the sense of tonality, the sense of harmony, musical memory etc. This gives an impression that tests are used as operational definitions of the above mentioned constructs.

We may now evaluate these constructs by applying the criteria of good constructs formed earlier. The constructs that will be handled are creative musicality, musical memory, musical intelligence, the sense of tonality, the sense of rhythm, the sense of harmony and the like.

First, have these terms been formed according to essential similarities and differences in musical behavior? In other words, when different behaviors have a common name, there must be something common in these behaviors which is considered more basic than their differences and, vice versa, when certain behaviors are considered to fall into different classes their differences must be more basic than their similarities. It seems quite evident that there is an important common part in the above mentioned behaviors.

If this were not so it would be very unusual that all these abilities would exist in one person; much more unusual than empirical evidence shows. If the common element is - as is hypothesized in this work - the ability to comprehend structures in acoustic material, it may well be considered as essential: without it these abilities would be impossible. It is difficult to say if the differences between the behaviors in question are essential. At least they are not as basic as the difference, for example, between the sensory capacities and the ones more dependent of the functions of the central nervous system seems to be.

Second, is there a possibility that these terms are circular? Do they imply something different from the operations they refer to or, perhaps, are they just the same thing expressed in different words? It is the author´s view that in spite of the face validity of these terms the danger of circularity is very close in many of them. For example, the notion that someone has a good sense of harmony is just to say in other words that he has been observed to find easily the right chors to a melody or to be able to separate the tones of a chord etc. It does not imply, for example, a specific function or area of the brain, it just describes the behavior.

Third, are these concepts basic in the sense that they necessarily should exist before the behaviors they are supposed to explain? Let us use the sense of tonality as an example. We may form two types of statements if the sense of tonality is considered a construct in the sense used here:

a) X has a good sense of tonality. He may, however, not be able to complete a tonal cadence, harmonize a melody

correctly etc. He will probably learn these operations relatively easily because of his sense of tonality.

b) X can complete a tonal cadence, harmonize a melody correctly etc. He has, then, a good sense of tonality. If he can not complete a tonal cadence, harmonize a melody correctly etc. he has not a good sense of tonality.

When viewed separately, these groups of sentences appear quite correct. When put together they are, however, contradictory. The case b excludes the case a: there can not be a case where a person has a sense of tonality but has not the corresponding abilities on the operational level. The cause-and-effect relation between the sense of tonality and its operational reflections cannot exist.

The reason for the dilemma is that the above mentioned operations are considered both operational definitions and effects of a construct. It is difficult to think of any other measures and effects, however. The only solution is that the sense of tonality is no real construct but a phenomenon parallel with the operations, that both the operations and the sense of tonality are operational reflections of something more basic and primary. If this were right, the case a above would be nonsense and case b simply a circular way of saying something about what a person can do.

As it has been said earlier correlations seldom give simple and clear answers to questions about the domains of constructs. This is the situation in the psychology of music, too. Most correlations are such that it is possible to interpret them in several different ways. Thus, when deciding about constructs one must carefully evaluate how sensible the constructs are and how well they are in accordance with each other and the known facts.

It seems that it is a more common fault to define musicality so that its domain is too wide rather than to make it too narrow. In other words, musicality is sometimes defined so that it apparently consists of parts which do not correlate with each other. This is probably the case, for example, when musical aptitude is thought of as "the properties necessary for success in the field of music". Definitions of this kind include a very wide variety of abilities, aptitudes, and personality traits such as intelligence, sensory capacities, motor abilities, emotional sensivity, perseverance etc. It is very improbable that these properties would all correlate significantly. It is very easy, however, to make research designs so that artificial correlations emerge. If, for example, a group of professional musicians were used as "the musically talented group" and a random sample of people as "the non-selected group" this artificial effect would probably be found. The properties mentioned above would correlate with each other and musical ability. This would, however, only show that the professional musicians are selected not only according to their musical ability but also according to the other properties in question. Besides, they practice the skills they need in their profession.

The variation in the wideness of the definitions of musical aptitude may cause problems which actually do not exist or at least are premature in this phase of research. Such is, for example, the old question concerning the "atomistic" and "omnibus" theories about musical talent.

It is often forgotten that in addition to true and false statements there is also a third type: the one without sense. An example of this is the statement "fairies have two wings". The truthfulness of this statement can not

be tested because instances of fairies can not be found; the sentence is therefore just a collection of empty words without meaning. The nature of musical aptitude is analogous with this to a great extent. Musical aptitude is defined so loosely that instances of it cannot be agreed upon. As far as instances of musical aptitude cannot be shown relatively accurately the problem of its closer nature has no sense. We may, however, apply the rules of good concept-formation and try to avoid defining musical aptitude against these rules.

It may be said that the atomistic view is a necessary effect of too wide a definition: if musical aptitude is defined so that it consists of non-correlating parts, it is of course "atomistic" in nature. Thus, the question is not of the phenomenon itself, but the way it is defined.

1.2. The structuralistic viewpoint

1.2.1. General

Structuralism is a tradition of thought which is difficult to define. This difficulty is a conequence of the many different meanings given to the word. In one, perhaps central, meaning structuralism refers to a school of thought that appeared in France in the fifties - although its roots are in the beginning of the century - and is still in an important position. French structuralism is concerned with the supposed structures which cause similarities in the superficially different parts of human culture such as language, social habits, myths and so on. "'Apparent' structures have their meaning but the important ones are 'under the surface'" (Caws 1970, 140). In this meaning structuralism seems to bear a close relation to Jung's archetypes. Because structuralism is

interested in what is common in many different expressions of human nature it leads to interdiciplinary coordinations (Piaget 1971, 137).

Linguistics is traditionally an area where structuralistic ideas have an important position. "Beyond descriptive linguistics, the description of the language code, there is the generative or transformational grammar of Chomsky and his followers...Transformational grammar is the attempt to explain why the native speaker is able to understand and produce sentences that may have never been written or spoken before. Its basic assumption is that language is a system of rules which can be variously arranged to form and understand sentences. Knowledge of a language is based on intuitive mastery of the rules." (De Cecco 1970, 3).

Structuralism is often also defined more broadly than above. In this meaning it refers to any way of thinking in which structures are given an important place. This attitude often leads to research which tries to devide phenomena into their smallest parts. Defining these parts, and especially the rules governing their relations to each other, are the main aims of this kind of research. Moles´ description of this kind of thinking has already been referred to (Karma 1973, 8) but it is so central in the present work that it is worth repetition: "(structuralistic theory) assumes that the world of representations can be divided into small pieces, elements of structure, which are put together in a definite way. The assembly of the elements is itself the structure ... Any organism, including a machine, is a structure; to understand a machine is to perceive that structure" (Moles 1966, 20, 33).

Probably the most important tradition of thought within the behavioral sciences that may be called structuralistic in the latter, broader sense is Gestalt Psychology. Much research in the field of music has been based on gestaltist ideas and this approach has had several benefits. There are, however, some concepts in Gestalt Psychology which have caused much confusion because of their ambivalent and diffuse nature. One central source of confusion is the gestaltist way of dividing phenomena into "wholes" and "parts" as well as the famous saying "a whole is more than the sum of its parts".

When critically viewed it is not at all clear what makes something a "part" or a "whole". In some cases a part in some system may be a whole when the situation is looked at from a different frame of reference. It is often best not to use these concepts at all. For example, Allport suggests the terms "structure" and "substructure" instead (Allport 1958, 617). It is the problem and the tactics of research that guide what level of a structure is viewed as primary.

The relation between wholes and parts has been an important philosophical problem for quite a long time. The statement "a whole is more than the sum of its parts" has been given different meanings by different theorists. A crucial question is what is meant by the expression "sum". It may be considered just the result of putting together the properties of the separate parts. This way of thinking is, however, naive and sure to cause problems when the actual properties of the whole are compared with this sum. In this case the interaction of the parts has been forgotten. The quality of a whole is not just the result of the properties of the parts but also a result of the way the parts have been put together.

The more parts there are the more relations there are between the parts, ie. the more complex the structure of the whole is. This complexity increases in an accelerating manner when the amount of parts becomes bigger. It is also good to remember that "parts" themselves may be structures and thus have properties caused by internal relations. There are many cases where the structure of the whole is more important than the quality of its parts.

One way of looking at the problem is to say that a whole has properties which cannot be derived from its parts, ie. they are more or less surprising, they cannot be predicted. These properties are called the "emergent" properties of the whole. This solution is, however, more a linguistic trick than a real explanation. The reason for our inability to predict the properties of a combination of elements may be that we simply do not know the parts well enough. If we did, we could say what the effects of putting them together will be. (Lagerspetz 1966, 38 - 46, Waddington 1970, 22). In other words it may be said that there is nothing mysterious in the properties of a whole; the unexpectedness in its quality is just a consequence of the limits of human thought.

According to Kaila (1944, 72) it has been a central thesis within the Gestalt Theory that a gestalt is necessarily something quite different from the relations the perception consists of. This view has been thought to be supported by the facts that "a gestalt is one and the relations are many", as well as that a subjective experience of the relations is not necessary for the forming of a gestalt.

There is a shade of mysticism in this kind of reasoning and it does not survive when critically analyzed. To say

that a gestalt is one and the relations are many is just to say that we have no <u>conscious</u> experience of conceiving the relations. The subjective feeling of "oneness" in the experience may well be explained as a consequence of the rapidity and inconsciousness of the data processing.

It is a central thought in the present work that understanding and perceiving "wholes" or structures is conceiving the relations in them. As more of the relations are conceived, the understanding or perceiving becomes better or clearer.

1.2.2. Music as a system of relations

It is hardly anything new to note that music may be thought of as a system of relations, ie. as structures. The nature of this system is, however, worth closer inspection. Although this inspection may be trivial to some degree, it is hoped that this results in easier understanding of some lines of thought in the theory and test construction.

The relations forming a piece of music are of almost innumerably different kinds. The generality or specificity of the relations vary to a great extent. A very general relation would be, for example, "same" or "different" while "a minor third higher" is a relatively accurately specified relation. The relations also vary in the dimension of objectiveness. "Two times longer" is an objectively measurable relation but there are, on the other hand, relations which have a meaning in some cultures and at some times only. An example of the latter type would be, for example, the tonic-dominant-relation in traditional western music. The relations may also be

strong and essential in the music as well as weak and of minor importance.

These relations exist as well between the primary units, individual tones, as between groups of sounds. Thus the primary units do not form directly the structure of a composition. It may be considered a general rule that the organization of a piece of music is more or less hierarchical in nature: the sounds form small structures which in turn group to bigger wholes etc. One of the aims of music analysis is to find this hierarchy, eg. showing the basic motives in a composition is usually considered important in the analysis. Meyer forms much the same idea in the following way: "Tonal probabilities exist not only within phrases and smaller parts of a musical structure but also between them. These probabilities are not necessarily the same ... Thus the statistical analysis of stylistic probabilities must be architectonic - different sets of probability must be discovered for different hierarchic levels." (Meyer 1969, 19).

1.2.3. Meaning in music

It is generally accepted that there must be some kind of meaning in music. The nature of this meaning is a question which has caused much disagreement and confusion. One major cause of this situation is that the meaning of music is difficult or even impossible to describe in words (Bengtsson 1973, 30). It is not important to handle the problem exhaustively here but some solutions may help to form a frame of reference.

Moles separates two kinds of information in a work of art: the semantic and the esthetic. "The semantic view-

point asks a question about the state of the external world, about its material evolution. The question must prepare decisions about either present or future acts or attitudes. This viewpoint prepares the receiving subject for an external reaction ... and in general, semantic information has a clearly utilitarian, but above all, logical character ... semantic information is exactly translatable into a foreign language, since it follows from the symbols and laws of a universal logic common to all languages ... Esthetic information does not have the goal of preparing decisions; it has no goal properly speaking. It does not have the characteristic of intent; in fact it determines internal states. Esthetic information is not translatable, that is, it has only equivalents, not equals." In music most of the information is esthetic information. (Moles 1966, 130, 137).

Moles has been able to show the existence of these two kinds of information by inventive experiments; this increases the value of the concepts. It is also interesting that these concepts may have a physiological explanation: linguistic abilities on one hand and spatial and musical abilities on the other seem to be situated in different hemispheres of the brain (Scheid - Eccles 1975, Rennels 1976).

According to Meyer, music gives rise to two kinds of meaning which he calls designative and embodied. A stimulus contains designative meaning "because it indicates or refers to something which is different from itself in kind. A stimulus or process may (also) acquire meaning because it indicates or refers to something which is like itself in kind." In the latter case the meaning is called embodied meaning. (Meyer 1966, 6).

According to information theory, an element has the more information the less probable it is. This rule is often applied to music analysis by saying that the less expected an element in music is the more meaning it has. This view may be correct but it is not self-evident. It has, for example, been found that the more probable a word in a language is the more meaning it has (Noble 1970, 152). Although it may not be correct to generalize from language to music this controversy may be considered a warning against hasty analogies.

While it is difficult to define what the meaning of music is, many writers both in the field of psychology and of music hold the view that structure is the bearer of meaning (Eg. Allport 1958, 108, 516, 544, Bengtsson 1973, 30, Moles 1966). This view is basically accepted and used as a basis of the present work. It seems, however, that the view can not be totally agreed with. For example timbre (when a piece of music is played with different instruments and the like) and tempo are properties of music which can hardly be considered "structure" in the meaning "relations within the work". In spite of this they may have an important effect on the meaning of the work.

1.2.4. Implications

A short summary of the basic structuralistic principles which are of importance here may be useful:

- An individual is said to perceive structures instead of certain amounts of primary sensations to the extent that he is conceiving the relations which the elements of the perception form.
- Music may be considered essentially as structures. The relations in these structures may vary in many ways. For example they may be different in respect to generality,

objectiveness, or importance. The relations do not exist only between the primary elements but also between the substructures.

- Most of the meaning of music is in its structure.

It may be considered an axiom that a musical person is one whc is able to perceive or experience a relatively great deal of the meaning of music. This varies with the familiarity of music, of course, but a musical person has the capacity to learn the ways in which the meaning is expressed in different kinds of music. A very unmusical person may be said to perceive music as relatively meaningless.

The famous definition by Révész seems to express essentially the same idea although there are parts in it which do not seem necessary. It is also not free from certain weaknesses such as circularity and dependence of culture as Larsen and Uddling have shown (Larsen - Uddling 1973, 65 - 72). In its original form Révész's definition is as follows: "Unter Musikalität im Allgemeinen, sind das Bedürfnis und die Fähigkeiten zu verstehen, die autonomen Wirkungen der Musik zu erleben und die musikalischen Äusserungen auf ihren ästetischen Wert (Gehalt) hin zu beurteilen." (Révész 1946, 163). In the English version of the book this is in the following, to some extent inexact form: "By musicality in general we are to understand the need and the capacity to experience the autonomous effects of music and to appraise musical utterances on the score of their objective quality (aesthetic content)." (Révész 1953, 132). If we leave off those parts of the definition which are most vulnerable to criticism, namely "the need" and "their objective quality" we get the core of the definition: musicality is the capacity to understand and experience music.

If the abovementioned axiom is accepted and the propositions derived from the structuralistic ideas are true it follows automatically that the property which differentiates a musical person from a non-musical one is mostly his ability to structure music, ie. to perceive the relations in it. Because it is sometimes difficult to define "music", it may be better to replace it with the expression "acoustic material".

2. Implications of the foregoing discussion on the testing of musical aptitude

An aptitude test should be of help when predictions are made, ie. it should measure properties which can be used in explaining an individual's future behavior. Any test measures, of course, present properties of the individual, but all properties have not the same significance when the future is estimated.

This work attempts to show that many abilities measured by musical aptitude tests may be said to be effects of musical aptitude and experience rather than musical aptitude itself. In other words, these abilities may not exist at all before a certain amount of experience in music has been attained. However, this is just when predictions are most needed.

Using these abilities as predictors would in this case be awkward to a great extent. The bicycle-driving example may again be used as an analogy. Let us suppose that bicycle-driving is used as an operationalization for sensory-motor co-ordination. In this case bad driving would indicate lack of co-ordination which is an apparently

erraneous conclusion: actually it may simply indicate lack of experience as well. The reason for the wrong conclusion is that the operationalization has been choosen inadequately; it measures the effect of capacity and training instead of the capacity itself.

Evidently it is difficult, if not impossible, to totally eliminate the effect of experience in testing musical aptitude (and, as a matter of fact, in testing any aptitudes). It seems just as evident, however, that present tests are not optimal in this respect. This work attempts to reduce the effect of experience by limiting the domain of the concept "musical aptitude" to structuring ability.

It may be argued that the terms critisized in this work (see p. 7) are not meant to indicate constructs but are just practical names for certain behaviors. They may be thought of as several operationalizations of the same construct(s) and used to get more reliable and valid results where the important and interesting variance is "filtered out". There are tests constructed according to this principle - many subtests measure several overlapping areas - and many of them are likely to be good. Two drawbacks may be mentioned which easily occur when tests of this kind are used:

1) The method is not economic. When just a relatively small part of the variance of each subtest is "true", interesting variance, the total length of the test must often be incoveniently increased for a reliable and valid total score.

2) The common variance that is filtered out may not be valid variance. When this method is used the biggest part of the common variance of the subtests must be a measure

of the required ability. If, for example, there is too big an amount of experience reflected in the results of the subtests, the total score may become a relatively pure measure of experience and the variance caused by ability would be handled as error variance. This would happen especially in situations where the test is homogenized for better reliability.

The central idea of the beginning of this chapter may be summarized as follows: a test of musical aptitude should measure the core of musical aptitude as directly and efficiently as possible. The natural way to proceed is to ask what this core is like and how it can be operationalized. The first question has already been answered: musical aptitude is considered essentially an ability to structure acoustic material. So the problem of measuring this ability is left.

In principle there are almost innumerable ways of testing structuring ability as the vast amount of tests of spatial ability shows. In practice this variety is much more limited, however, because of the several requirements this special problem creates. These requirements have been listed earlier (Karma 1973, 13 - 15).

The structuralistic principles gathered in the foregoing chapter make the following properties of the test important:

1) The test must be constructed so that it measures the ability to conceive groups of relations instead of absolute qualities.

2) The relations must be objective.

3) The relations must be relatively general - very specific

relations are thought to be too much affected by training and experience.

4) The items must be constructed so that there are substructures in them.

In an attempt to solve the first problem, small differences in the items have been avoided. The differences used in the different versions of the test are such that they should be clear to every normal person. (Karma 1975, 1).

The second, third, and fourth requirements are closely related and can be handled together. These requirements may be filled by constructing the items so that they consist of repetitions of a small figure of tones. The figures are themselves structures and repeating them forms the desired hierarchy within the items. Repeating is also a very objective kind of structure forming; there is only one way of dividing the items into substructures according to the instructions given. Problems of this kind can also be made sufficiently general. The subject may, for instance, be asked to detect differences in the order or amount of tones instead of, say; thirds, triplets,syncopation etc. which would require training or experience.

In an ideal case the subject should both locate the substructures within an item and conceive their internal structure to be able to give the right answer to the item. It is very difficult to compose items which would be quite satisfactory in both these respects - the subjects can often find shortcuts and solve the problems with less information about the structure of an item than actually intended. Six different versions of the test have been composed and tested in.use at the time of writing and the experimenting is still going on.

It may be adequate to remind the reader here that the objective of the test construction handled above has not been to develop a test which would predict success in music in the best possible way. The aim has been to validate the theoretical considerations about the nature of musical aptitude.

3. Some special problem areas

3.1. The relation between auditive and visual structures

It is often said that visual and musical structures are essentially different, in addition to belonging to different modalities, because musical structures are temporally successive while visual structures are not. It may be said that this difference has been exaggerated - there are remarkable similarities which diminish the sharpness of this distinction.

The whole visual field is not perceived equally intensively and clearly at the same time. This is caused by at least two factors: first, the eyes can see only a limited area clearly because of their structure; second, usually one concentrates on a part of the visual field only. These areas are usually but not necessarily the same.

This operation is called scanning within the information theory. Small portions of a structure are sent or received successively, the image of the whole is constructed by replacing these parts according to information about their original relative positions. This knowledge of the original relations is necessary to prevent a nonsense end result.

Television is a good example of this working principle. The original image is sent line by line through a one-dimensional channel. The receiver "knows" where to end one line and where to begin another because the sender and the receiver are synchronized. The brain can reconstruct the original image because the place to which the eyes had been directed earlier may still be in the visual field and because the brain has information about the directions in which the eyes have been moved. Because of the scanning procedure both the visual and auditive images are constructed by the central nervous system from more or less successive, electro-chemical impulses.

The partial similarity of the functions of these modalities may be thought to cause correlation in their work which could be empirically found. This view may be thought to be supported by the fact that spatial and musical areas of the brain seem to be closely located (Scheid - Eccles 1975). This similarity might also be the basis of the general artistic ability which is often spoken about.

3.2. The relation between musical and mathematical aptitudes

It is a relatively usual view that musical and mathematical aptitudes are related (Eg. Roiha 1965, 146). Opinions about this seem to be strongly divided, however; practically as many researchers are for this view as against it.

Lists of mathematically gifted musicians as well as of mathematicians who have been amateur musicians are often presented to support the view that there is a relation between these aptitudes. There are, however,

so many exceptions of this rule that the opposite view can be well supported, too. It is also often said that music and mathematics are traditionally related areas. Again, this may be also interpretated so that the old formal relationship has guided researchers' thoughts, making them believe that a real, psychological relation exists.

When this problem is studied, simple numerical ability and the more abstract ability needed for higher mathematics must be separated from each other. According to Smith (1964, 101 - 134) there is considerable evidence for this distinction. Abstract, more advanced mathematics seems to be related to spatial ability. If it is so, there may well be a relation between musical and mathematical abilities. As it has been suggested earlier in this work (Karma 1973, 11) there may be a relation between musical and spatial abilities, too. Musical, mathematical, and spatial abilities may thus all be considered forms of related, non-verbal abilities.

3.3. The relation between basic musical capacities and success in the field of music

According to the model presented earlier (Karma 1973,12) sensory capacities and structuring ability (musical aptitude) are separated from each other. This is done because they are supposed to be relatively independent and thus it would be against the concept-forming rules to keep them together in one concept. These two terms are implied here when the expression "basic musical capacities" is used.

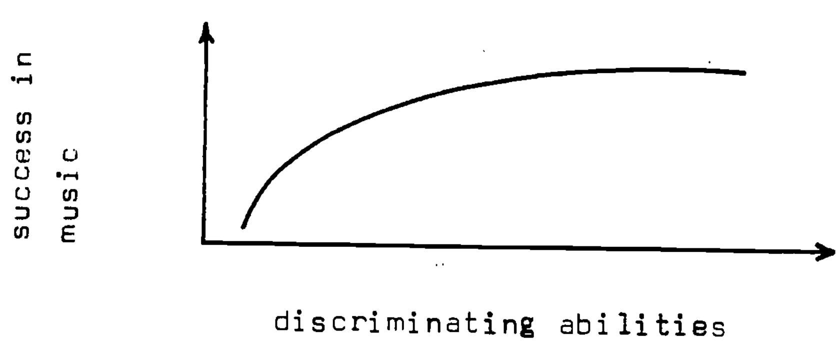
Within the behavioral sciences correlation is the most

widely used measure of relationship. This implies the assumption of linear relations which is not always adequate. In cases where other than linear types of relations can be expected this possibility should be empirically tested. It seems that non-linear relations may well exist between the basic musical capacities and success in music.

We may handle the sensory capacities first. It is often remarked that the degree of discriminating abilities measured in test situations is not actually needed in music. What a musician needs is an ability to dicriminate sufficiently well when perceiving or producing a relatively great deal of musical material simultaneously or successively, not the ability to discriminate isolated, meaningless sounds with extreme accuracy. This may be thought to be the case with structuring ability, too. It may be said that the basic musical capacities become stunts instead of useful tools when utmost accuracy is demanded.

The relations between the three areas handled in the model on one hand (Karma 1973, 12) and actual musical practice on the other may thus be said to be the following:

Sensory capacities form the basis to all other sides of musical behavior. A certain discriminating ability is needed for the use of one's structuring ability and satisfactory understanding and performing of music. When a satisfactory level of discriminating ability is reached its practical significance will increase more slowly until no relation with success in music can be found. The following hypothetical diagram illustrates the relation:



The following hypothesis for later study may be formed: The relation between sensory capacities and success in music is curvilinear. It seems reasonable to suppose a similar relation between structuring ability and musical practice: The relation between structuring ability and success in music is curvilinear.

If these hypotheses are true they have practical educational significance: in selecting and evaluating music students a certain sufficient level of the basic musical capacities should be taken into consideration, when this level is reached other capacities, such as intelligence and personality, should be given an increasing significance.

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