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THE EFFECT OF TIMBRE ON THE INTERVAL PERCEPTION AND IDENTIFICATION SKILL OF INSTRUMENTALISTS

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INTRODUCTION

Need for the Study

The manner in which individuals respond to combinations of tones has been a topic of speculation and discussion for many years. One of the earliest attempts to explain the perception of tones was set forth in the research and writings of Helmholtz.[1] The Helmholtz theories were an early attempt to answer questions relating to the phenomenon of harmonic upper-partial tones and their relationship to tone quality. In addition, the theories dealt with combinational tones and beats. Helmholtz's work served as a springboard for more sophisticated studies into musicality and perceptual skills.

In the early part of the twentieth century, two divergent attitudes emerged regarding musicality and aural discrimination. Musicality was approached through Gestalt Psychology by Mursell, while Seashore's theories were based on an atomistic concept of abilities. These opposing views were the basis for much of the early research in the area of perceptual skills.

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[1]H. L. F. Helmholtz, <u>On the Sensations of Tone</u>, trans. Alexander Ellis (6th ed.; New York: Peter Smith, 1948), p. 4.

The Gestalt concept of musical abilities was the theoretical framework for Mursell's work in the field of music psychology. Mursell felt that the basic components of musical stimuli, sound and rhythm, were assimilated and sorted out from within the individual's own perception.[1] According to Mursell, the skill of interval identification was among the most remarkable of all the perceptual phenomena.[2] For this reason, the perception of musical intervals was an ability which was most fundamental to his view.

Those writers in opposition to the views of Mursell advocated an atomistic concept of musicality and held to the premise that musical aptitude was largely innate and that it was not influenced by external forces. Carl Seashore, a leading exponent of this view, felt that an individual's capacity for the perception of musical pitch, time, loudness, and timbre was largely inborn and after an early age did not vary greatly.[3]

However, more recent research studies have revealed that perceptual skills can be modified in different ways. It has been found that perception of the component

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[1]James L. Mursell, The Psychology of Music (New York: W. W. Norton and Company, 1937), p. 50.

[2]Mursell, p. 81.

[3]Carl E. Seashore, Psychology of Music (New York: McGraw-Hill Book Company, Inc.), p. 3.

parts of music can vary with training and experience and that the variables of pitch, loudness, time, and timbre may influence aural perception skills.[1] Results of research studies conducted by Buttram,[2] Greer,[3] and Cuddy,[4] concerned with aural perception skills as a function of parameter change, indicated that the various contextual factors did influence participants' aural perception skills.

Although the perception of musical intervals has been a topic of study for some years, much of the research effort has focused on the ability to sing or write the interval after one of the pitches has been sounded. Pikler reported that previous research in the area of musical interval sense has been devoted to the skill of simple recognition in multiple choice situations with little attention focused on the problem of the perception

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[1]William Robert Swaffield, "Effect of Melodic Parameters on Ability to Make Fine-tuning Responses in Context," Journal of Research in Music Education, XXII (Winter, 1974), p. 305.

[2]Joe Beck Buttram, "The Influence of Selected Factors on Interval Identification" (unpublished doctoral dissertation, University of Kansas, 1967), pp. 136-141.

[3]R. D. Greer, "The Effect of Timbre on Brass-Wind Intonation," Experimental Research in the Psychology of Music, VI (1970), pp. 65-94.

[4]Lola Lane Cuddy, "Practice Effects in Pitch Perception" (unpublished doctoral dissertation, University of Toronto, 1965), pp. 75-91.

of musical intervals in isolation.[1]

A perusal of available literature reveals a dearth of empirical evidence concerning the effect of timbre on aural discrimination skill. A study by Leonard does examine the effect of intrinsic and contextual characteristics of the tone stimulus on pitch discrimination.[2] Leonard reported that the factors of intensity, register, context, duration, and interstimulus time interval had a significant influence on participants' pitch discrimination skill. The factor of timbre was not found to be an influence.

The sensitivity to musical intervals and the aural perception skills implied in making correct judgments of intervals is considered basic to good musicianship. Indeed, the collegiate music student is asked to devote a good deal of time learning to recognize the various combinations of pitched sounds. However, textbooks and workbooks on aural perception make very little attempt to instruct students as to the manner in which timbral variation may affect their aural acuity. Consequently, the effects of timbral changes on perception skills is

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[1]Andrew G. Pikler, "History of Experiments on the Musical Interval Sense," Journal of Music Theory, X, 1 (1966), pp. 84-85.

[2]Nels Leonard, Jr., "The Effect of Certain Intrinsic and Contextual Characteristics of the Tone Stimulus on Pitch Discrimination" (unpublished doctoral dissertation, West Virginia University, 1967), pp. 6-15.

seldom discussed by authors of aural perception text books such as Thompson and Delone,[1] and Spohn.[2]

For the reasons cited, further inquiry into the effect of timbre on various aural discrimination tasks may yield significant results. Specifically, this preliminary investigation has opened the question of timbral effect on the skill of harmonic interval identification to intensive, experimental research. Peripherally, it might be asked what effect timbre has on the various perception and discrimination skills of instrumental musicians in general. Specifically, does the experience of playing a musical instrument over a period of years encode a certain ability to make more refined judgments of intervals when the sound generating device is the subject's primary performance medium?

Purpose of the Study

The present study represents an attempt to determine the effect of timbre on selected interval identification skills of collegiate musicians. Specifically, the study was concerned with the ability of undergraduate musicians to perceive and identify intervals

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[1]William E. Thompson and Richard P. Delone, _Introduction to Ear Training_ (California: Wadsworth Publishing Co., 1968), p. 3.

[2]Charles L. Spohn and B. William Poland, _Sounds of Music: Harmonic Intervals_ (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967), p. 3.

as a function of timbral experience gained through the primary performance medium.

Hypotheses

It was hypothesized that the ability of undergraduate wind, percussion, and keyboard musicians to perceive and identify harmonic intervals generated by different conventional instruments would be influenced by previous experience gained through the student's primary performance medium. It was further hypothesized that the subject's ability to perceive and identify intervals would be influenced by the timbral source employed to produce the intervals; and, that the intervals would be more accurately perceived and identified when produced by instruments the subjects regard as their primary performance medium.

To facilitate the drawing of conclusions relating to the major purpose of the study, the following null hypotheses were tested for significance:

NH_1: There will be no difference in the mean interval identification scores of subjects grouped according to major instrument classification.

NH_2: There will be no difference in the mean interval identification scores of subjects on the timbral subtests of the interval identification measure.

NH_3: There will be no difference in the mean scores of each of the instrumental groups on the five timbral subtests of the interval identification measure.

Definition of Terms

In order to avoid multiple interpretations of certain terms used in the present study, the following explanations and definitions are provided:

1. Musical Intervals: The distance in pitch between two tones. Intervals presented in this study are harmonic, that is, they are presented at the same time. In this study all intervals are contained within the span of one octave.
2. Timbre: The quality of a tone that distinguishes one instrument from another. In this study five different instrumental timbres were used. Four were utilized individually and two were combined to create one mixed timbre subtest.
3. Aural Discrimination Skill: In this discussion it is the ability to identify selected harmonic intervals as generated by the various timbral sources employed.
4. Test of Interval Identification: The

instrument developed for this study to determine the effect of timbre on harmonic interval perception and identification skills of the experimental subjects. The instrument consists of five subtests, each employing a different timbre. The timbres selected for study included clarinet, trumpet, piano, pure tone, and a mixed timbre utilizing both french horn and flute. In each subtest the twelve intervals contained within the span of an octave plus three additional simple intervals were presented once, harmonically. Subjects were asked to identify a total of seventy-five (75) musical intervals. The experimental variable in each subtest was the change of timbre.[1]

Basic Assumptions

Certain assumptions were made about the students, the data collection instrument, and the testing methods employed in the study. The most important of these assumptions are listed as follows:

1. Interval identification is a perceptual skill and can be improved by study and

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[1]A thorough discussion of the test development and construction is contained in Chapter III.

practice.

2. A test of interval identification can be developed that is a valid and reliable instrument for measuring the effect of different timbres on the achievement scores of subjects in the five subtest areas of the criterion instrument.
3. The students in the experiment were a true representation of a normal population of undergraduate instrumentalists available at the participating institutions.
4. The aural acuity of the subjects in the experiment ranged within normal limits.

Limitations of the Study

The present study was concerned with the aural perception and identification of harmonic musical intervals. The study was limited to the effect of four selected timbres plus the mixed timbre of french horn and flute on the skill of harmonic interval identification. The intervals employed in the study were limited to those contained within the span of an octave and ranging from E, below middle C, to B^b above the treble staff. In addition, certain limitations were placed on the study in order to make it feasible.

First, the subjects of the experiment were limited to undergraduate musicians who had a modicum of classroom training in the skill of interval identification.

Second, the students were currently enrolled in or had completed freshmen or sophomore ear training courses or the equivalent at their respective colleges and universities.

Third, the experimental subjects were limited to those instrumentalists whose playing experience on the selected instruments was equal to or above the mean years of study for their respective instrumental group.

CHAPTER II

REVIEW OF RELATED LITERATURE

The present study was concerned with musical interval perception and identification skill as a function of timbral source and primary performance medium. The current chapter presents a review of the literature pertinent to this subject with emphasis on the basic role played by the interval in the music of all cultures. In addition, an historical perspective relative to the development of interval tuning and temperament is contained herein.

Introduction

The musical interval is an integral component of the theoretical foundations of all music. Reference to the musical interval in Western music can be traced to Greek treatises of the fourth century B. C.[1] Concerning the interval as a basic unit of world musics, Révész comments thus:

> If we examine the music of every race for the factors that are common to all and are peculiar only to the expressive forms of music, we come to the conclusion that every form of music, primitive as it may be, must manifest three characteristics: fixed intervals, their

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[1]Donald Jay Grout, A History of Western Music (New York: W. W. Norton and Co., 1960), pp. 11-12.

> transposition to various pitches, and their use in heterogeneous, rhythmically articulated tone combinations.[1]

Although the number and size of tones used in scale systems are cultural and time variables, all but the most primitive of musical systems utilize pitched sounds in predictable relationships. Nettl claims that almost all possible tone combinations are employed in the scale systems of cultures throughout the world from simple scales of two tones to more complex heptatonic scales resembling the familiar Western diatonic scale.[2]

Western music, historically, has developed in terms of a well-defined musical notation system employing twelve semitones of varying sizes. Hood observes that the limitation of twelve pitches within the octave is characteristic of music of the Western world.[3] In contrast, many non-Western musical systems exhibit a flexibility of intervallic relationships that is absent from the composed-performed music of the Western world.

The inclusion of the interval as a fundamental concept in music systems of various races and cultures of

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[1]G. Révész, Introduction to the Psychology of Music, trans. G. I. deCourcy (Norman, Oklahoma: University of Oklahoma, 1954), p. 220.

[2]Bruno Nettl, Music in Primitive Culture (Cambridge: Harvard University Press, 1956), pp. 47-50.

[3]Mantle Hood, The Ethnomusicologist (New York: McGraw-Hill Book Co., 1971), p. 86.

the world is important, but the value for the present discussion lies primarily in its impact on the theoretical and acoustical constructs of Western music. For example, Hindemith believed that the bridging of a gap in space produced melodic tension and that the simultaneous sounding of two tones produced harmony. According to Hindemith:

> . . . the Interval formed by the connection of two tones, is the basic unit of musical construction.[1]

The development of a rational system of scales and intervals based on the twelve basic intervals of the modern chromatic scale, out of all the possible frequencies within the range of hearing, has been an evolutionary process. In this regard Révész states that there are more than 1,000 discernable notes in the two-line octave alone.[2] The extraction of only a small number of frequencies from an almost infinite number available in the sound spectrum and the subsequent codification into a theoretical system appears to be one of the great feats of mankind.[3]

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[1]Paul Hindemith, The Craft of Musical Composition, trans. Arthur Mendel (New York: Associated Music Publisher Inc., 1942, Book I), p. 57.

[2]Révész, p. 219.

[3]Richard Franko Goldman, Harmony in Western Music (New York: W. W. Norton and Co., 1965), p. 4.

The Musical Interval: An Historical Perspective

The equal-tempered interval, currently accepted as a standard for instruments of fixed pitch in Western music, has evolved through a series of different tuning systems and temperaments. An examination of the evolutionary process reveals that the precise size of musical intervals varies within limits depending on the tuning system in vogue.

The recorded history of Western music begins with the establishment of mathematically determined intervals and scale systems in ancient Greek civilization. There were several systems of Greek tuning based on melodic intervals obtained by means of a monochord. The most influential in the history of Western music was the tuning system attributed to Pythagoras who lived during the sixth century B. C.[1] The Pythagorean system is based upon the intervallic relationship of the octave and the fifth, the first two intervals of the natural harmonic series. Using simple ratios of 1:2 and 2:3, it was possible to determine all of the notes in the diatonic scale. The tones are obtained by constructing a series of successive fifths above the fundamental and reducing them back to the written span of an octave.

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[1] J. Murray Barbour, Tuning and Temperament (East Lansing: Michigan State College Press, 1953), pp. 2-3.

Although Pythagoras himself apparently did not write on the subject of music, this system of interval arrangement credited to him was favored by Boethius who wrote an influential treatise on music in the early sixth century A. D.[1] Boethius described other systems of tuning but gave detailed accounts only for the Pythagorean system.

Pythagorean intonation seems to have served the Middle Ages well but alternate sources of tuning became necessary with the development of polyphony and the necessity of dealing with harmonic as well as melodic intervals. The Pythagorean third, sixth, and seventh were too sharp to be acceptable as harmonic intervals,[2] but writers on music until the fifteenth century advocated exclusive use of Pythagorean intonation.

A new system of tuning appeared in the fifteenth century.[3] This system, advocated by Ramis, contained intervals less cumbersome than the complicated Pythagorean ratios. Elements of both Pythagorean and just intonation were incorporated into the system. Just intonation, based on the principle of natural fifths and thirds, while proposed from time to time has never been of practical use

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[1]Barbour, p. 3.

[2]Wilmer T. Bartholomew, Acoustics of Music (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1952), p. 171.

[3]Barbour, p. 4.

as a workable system.[1] Just intonation, however, has been used in combination with other systems. The system advocated by Ramis was similar to Pythagorean tuning but contained four pure thirds. Ramis appeared as the first of many reformers in a series of attempts to develop a compromise system of temperament adapted to the contrapuntal style of his time.

A further compromise of theories was advocated by Aron in the early sixteenth century.[2] This system of temperament was described as meantone temperament and resulted from slightly diminishing the first four fifths in the series. This alteration of fifths resulted in a pure major third and, in practice, produced a mixture of perfect and tempered fifths allowing modulations through three flats and three sharps without the necessity of retuning.[3] This system remained viable until the equal-tempered system emerged in the middle of the eighteenth century.

Equal temperament was a further attempt at a compromise necessitated by the limitations of earlier systems. The earliest tuning by a system approximating equal temperament is mentioned by Lanfranco in the

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[1]John Backus, The Acoustical Foundations of Music (New York: W. W. Norton and Co., Inc., 1969), p. 127.

[2]Barbour, p. 11.

[3]Bartholomew, p. 181.

sixteenth century.[1] Although the system was originally designed for the clavichord and organ, it appears that lutes and viols were generally tuned to equal temperament by the middle of the sixteenth century.

The equal-tempered system is characterized by the twelve equal semitones within the octave. Thus, the interval from C to C# would be mathematically and acoustically the same as the interval from C# to D. By using this temperament, all like intervals become the same size. This created equality within the intervals and keys, and made possible modulations to any key without the necessity of retuning. The acceptance of the equal-tempered system of tuning during the eighteenth century was a compromise made necessary by ever increasing demands for wide-ranging key relationships by composers. Equal temperament was adopted, and has been accepted by most Western cultures as the most practical system of temperament until the musical-cultural revolution of the twentieth century.

Table 1 compares the frequency ratios and deviations in cents of the Pythagorean, just, and equal-tempered systems.

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[1]Barbour, p. 45.

Table 1. Frequency Ratios for Pythagorean, Just and Equal Temperament

Interval From First Tone	Scale on C	Pythagorean Intonation	Cents	Just Intonation	Cents	Equal Temperament	Cents
Major Second	C-D	8:9	204	8:9	204	400:449	200
Major Third	C-E	64:81	408	4:5	386	50:63	400
Perfect Fourth	C-F	3:4	498	3:4	498	227:303	500
Perfect Fifth	C-G	2:3	702	2:3	702	289:433	700
Major Sixth	C-A	16:27	906	3:5	884	22:37	900
Major Seventh	C-B	128:243	1,110	8:15	1,088	89:168	1,100
Perfect Octave	C-C	1:2	1,200	1:2	1,200	1:2	1,200

Definition of Timbre

A functional definition stated by Backus places the subject of timbre in a perspective appropriate for use in the present study:

> [Timbre is] . . . the characteristic of a tone that can distinguish it from others of the same frequency and loudness.[1]

Seashore[2] and Olson[3] state that sound waves have four characteristic properties; frequency, amplitude, duration, and form. Any sound, from a simple pure tone to the most complex of musical tones, can be analyzed and reduced to these four basic properties. Each of the properties has physical as well as perceptual characteristics. The physical property, frequency, is defined as cycles per second and is perceived as pitch. Physical intensity can be described in terms of amplitude and is perceived as loudness. The physical property, duration, refers to the length of time a tone lasts and is perceived as time. The physical property, form, refers to the shape of the sound wave and is perceived as timbre.

Lundin elaborates further on the physical and psychological characteristics of the sound source:

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[1]Backus, p. 4.

[2]Carl E. Seashore, Psychology of Music (New York: McGraw-Hill Book Company, Inc., 1937), p. 16.

[3]Harry F. Olson, Music Physics and Engineering (2nd ed.; New York: Dover Publishing Co., 1967), pp. 242-247.

> Objective psychologists prefer to consider what have been formerly called the physical and psychological aspects of the sound stimulus as the vibrational and tonal. Both of these attributes characterize the same stimulus object, sound. They are both sets of qualities which serve to describe it as a stimulus object . . . Both sets of properties refer to the stimulus side of the psychological event.
>
> On the other side is the organism which is responding to these sound stimuli . . . The physicist might be particularly interested in studying the vibrational aspects of the stimulus, measuring the frequency or intensity of the sound wave, while the psychologist would be more interested in examining how people react to the tonal aspects, as in the determination of an individual's sensitivity to differences in pitch or loudness.[1]

Timbre is that element which is described in terms of wave form. Wave forms range from the sine wave through an infinite number of complexities to include the richest sounds possible and continuing on to include complex forms described simply as noise.[2]

The timbre of musical instruments is determined, in part, by the number and relative intensity of the

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[1]Robert W. Lundin, An Objective Psychology of Music (New York: The Ronald Press Company, 1953), p. 12.

[2]Seashore, p. 20.

partials.[1] Flute and oboe tone quality can be distinguished as a result of the relative strength and intensity of the overtone series of the two instruments. Flute tone is characterized by a strong fundamental while oboe tone quality is relatively weak in the fundamental with stronger emphasis in the frequency range from 500 to 1,500 cycles per second.[2]

The fundamental pitch, also described as the first partial, and the partials above the fundamental are referred to as the harmonic series. The first sixteen partials of the harmonic series beginning on low C are shown in Figure 1. The partials do not end with the sixteenth, rather, they continue in ever smaller intervallic units.

Seashore's treatise on instrumental timbre provides a more technical description of the timbre phenomenon:

> Putting all these facts together we obtain a definition of timbre as follows: Timbre is that characteristic of a tone which depends upon its harmonic structure as modified by absolute pitch and total intensity. The harmonic structure is

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[1]In addition to the fundamental pitch, most musical tones contain other weaker tones called "partials". These partials are created by the vibration of individual parts of the vibrating string or column of air. This is described more fully in the section dealing with the harmonic series.

[2]Olson, pp. 221-225.

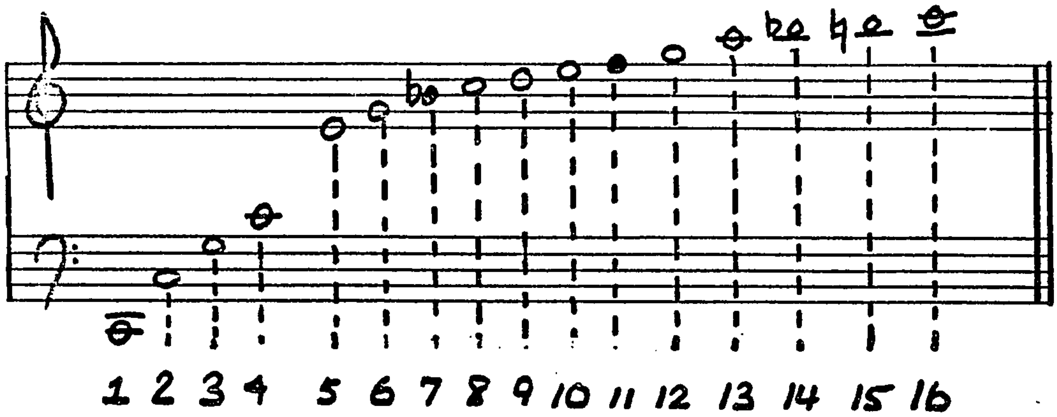

Figure 1. Harmonic Series on C

> expressed in terms of the number, distribution, and relative intensity of its partials. Recent experiments show that we must also take phase relations into account. Physically the timbre of the tone is a cross section of the tone quality for the moment represented by the duration of one vibration in the sound.[1]

Concerned with the design of a new musical instrument, Taylor offers a more inclusive definition of tone quality and factors that influence timbre. Supporting the statement of Seashore, Taylor ascribes three major factors to the origin of differences in musical tone quality.

The first possibility is simultaneous vibration in several modes of resonance. This gives rise to a harmonic mixture with a perfectly repetitive wave shape. The second major factor to influence tone quality is an amplification system with resulting transient effects.

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[1]Seashore, p. 97.

Factor three includes transients caused specifically by the method of initiation of the sound.[1]

In addition to the three factors that are primary determinants of tone quality or timbre, Taylor discusses two additional areas. These secondary areas are often of a type that permit one particular performer or instrument to be distinguished from others of the same basic type. The two are identified by Taylor as formants and the terminal transient effect. This final category includes vibrato and incidental noise.

In summary, it has been shown that wave form is primarily responsible for the tone quality of musical sounds. Complex musical tones are composed of frequencies vibrating in addition to the fundamental. These frequencies or partials sounding above the fundamental occur in an order that is known as the harmonic series. It is further demonstrable that the number, relative strength, and intensity of these partials are the primary determinants of differences in tone quality. In addition to the major factors of tone quality, it is Taylor's view that two secondary areas, formants and terminal effects, contribute to the quality and character of perceived sound.[2]

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[1]C. A. Taylor, The Physics of Musical Sound (New York: The American Elsevier Publishing Co., 1965), p. 106.

[2]Taylor, pp. 106-110.

Perception of Aural Stimuli

Interest in the nature of musical talent began to attract attention during the latter half of the nineteenth century. Several early studies listed characteristics which respective authors deemed to be important indicators of musical talent. In the literature concerned with musical measurement some confusion exists regarding the use of the terms musicality, musical aptitude, musical talent, and musical ability. Lehman comments that writers use the terms inconsistently.[1] In an attempt to clarify the issue, he defines musical aptitude as potential for musical achievement. Musicality and musical talent are used in a similar context while musical ability refers to accomplishment, whether acquired or innate.

A description of musicality is often approached through an analysis of musical ability in an effort to identify factors contributing to musical behavior. Researchers approaching musicality in this manner compile lists of attributes common to individuals recognized as musical. The number and kind of attributes observed by the researchers are generally different, but common abilities do occur. Included among these attributes are the ability

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[1]Paul R. Lehman, Tests and Measurements in Music (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1968), p. 7.

to detect differences in pitch, intervals, and chords.[1]

The first aptitude test to gain wide recognition and acceptance in the music field was the Seashore Measures of Musical Talents.[2] Published originally in 1919, these measures exerted a strong influence on music education, and a revised form continues in use today.[3] The 1939 revision contains six separate tests including Pitch, Loudness, Rhythm, Time, Timbre, and Tonal Memory. The timbre discrimination test replaced the original test of consonance.[4] Additional musical aptitude measures employ tests of timbre discrimination. The aptitude test by Kwalwasser and Dykema is an example.[5] In this discrimination test, subjects hear the sounds of musical instruments and are asked to determine whether they are the same or different.

The majority of music test, both standardized and non-standardized, which have been developed in the last forty years seem to fall into two broad categories: (1) test of musical aptitude and (2) tests of musical

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[1]William E. Whybrew, Measurement and Evaluation in Music (Dubuque, Iowa: William C. Brown Co., 1962), p. 86.

[2]Whybrew, p. 6.

[3]Lehman, p. 5.

[4]Lundin, p. 178.

[5]Jacob Kwalwasser and Peter Dykema, Kwalwasser-Dykema Music Tests (New York: Carl Fischer, 1930).

achievement.[1]

Lehman[2] and Whybrew[3] identified a third category of tests which they called "tests of musical performance." Bullock identified still another type of music test which purports to assess a variety of personal attributes such as mood, taste, interest, opinion, preference, attitude, judgment, perception, and appreciation.[4] Collectively, these instruments are often referred to as music appreciation tests. Bullock further divided music appreciation tests into three groups: (1) measures of perceptive ability, (2) verbal measures of attitudinal disposition, and (3) tonal measures of attitudinal responses.[5]

Theories dealing with the nature and evaluation of musicality fall into two divergent categories. The atomistic view proposes that musicality is the result of the perception of a number of musical attributes, each of which is capable of isolated measurement. The second school of thought approaches the subject of musical

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[1]Edwin Gordon, The Psychology of Music Teaching (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971), p. 5.

[2]Lehman, p. 70.

[3]Whybrew, p. 164.

[4]William J. Bullock, "A Review of Measures of Musico-Aesthetic Attitude," Journal of Research in Music Education, XV (Summer, 1967), pp. 331-344.

[5]Bullock, p. 333.

aptitude through Gestalt Psychology. The controversy surrounding the nature and evaluation of musical aptitude is not settled. Empirical evidence supporting either side is not sufficient to resolve the issue.

Seashore proposed an atomistic view of musical aptitude. According to Seashore, musical aptitude could be studied through the measurement of an individual's response to the discrimination of pitch, time, loudness, and timbre. The sensory attributes isolated by Seashore were referred to as the senses of pitch, time, loudness, and timbre. Further, Seashore felt these discrimination skills are innate and do not vary to a great extent after early years:

> On the basis of our experiments in measuring these sensory capacities, we find that the basic capacities, the sense of pitch, the sense of time, the sense of loudness, and the sense of timbre are elemental, by which we mean that they are largely inborn and function from early childhood.[1]

The atomistic view of musical aptitude contends that the perception of the four basic properties of sound are functions which are independent and capable of isolated measurement.

Mursell's writings, based largely on Gestalt Psychology, presented an opposing view by suggesting that the various component parts of musical stimuli are

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[1] Seashore, p. 3.

peripheral in origin. Upon hearing a stimulus the patterns are organized and sorted out, not from the outside stimulus, but from the action or perception of the mind from within.[1] According to Mursell, the isolated measurements of sensory capacities are not important as indicators of musicality. The Gestalt concept of musical aptitude focused attention on a general factor of musicality rather than a number of separate and rather independent capacities.

Recent research studies do not support the theories of Seashore, but contend that the perception of basic musical properties are not isolated and separate but interdependent. For instance, Saldanha and Corso found perception and recognition of timbre to be somewhat dependent on the frequency of the stimulus.[2] Sergeant also cited evidence that timbre is a function of frequency; loudness is somewhat dependent on frequency; and frequency is influenced by duration.[3]

In addition to operating in an interdependent manner; the four parameters of sound have been shown to

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[1]James L. Mursell, The Psychology of Music (New York: W. W. Norton and Company, 1937), p. 50.

[2]E. L. Saldanha and J. E. Corso, "Cues and Identification of Musical Instruments," Journal of the Acoustical Society of America, XXXVI (1964), pp. 20-21.

[3]Desmond Sergeant, "Measurement of Pitch Discrimination," Journal of Research in Music Education, XXI (Spring, 1973), pp. 67-77.

act independently on other perception skills. Haack, for example, studied the effect of intensity on the discrimination of pitch, rhythm, duration, loudness, timbre, and tonal memory.[1] Haack felt that to heighten aural discrimination and perception was a primary goal of music education, but various aspects of the physical and cultural environments might be affecting this primary goal. Haack's test was structured around and adapted from the Seashore _Measures of Musical Talents_. Each item selected was randomly assigned a loudness level in addition to other experimental variants. Results of the experiment revealed that of six discrimination skills under investigation, the intensity variable significantly influenced the perception of rhythm, duration, loudness of tones, and timbre. The discrimination skills of pitch and tonal memory were not significantly affected by the various loudness levels used in the experiment.

Recent studies by Zeitlin,[2] and Henning and Grosberg[3] reported that in rather carefully controlled test

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[1]Paul A. Haack, "The Influence of Loudness on the Discrimination of Musical Sound Factors," _Journal of Research in Music Education_, XXIII (Spring, 1975), pp. 67-77.

[2]L. R. Zeitlin, "Frequency Discrimination of Pure and Complex Tones," _Journal of the Acoustical Society of America_, XXXVI (1964), p. 1207.

[3]G. B. Henning and S. L. Grosberg, "Effects of Harmonic Components on Frequency Discrimination," _Journal of the Acoustical Society of America_, XVIV, 5 (1968), pp. 1386-1389.

situations subjects' perception of pitch, high or low, was more accurate when complex rather than pure tones were used.

Sergeant's study of pitch perception drew upon data presented by Saldanha and Corso, and Henning and Grosberg to examine the effect of pure tones on pitch discrimination.[1] Sergeant's first hypothesis stated that complex signals, because of the partials present, make the subject's discrimination task much easier. The second hypothesis stated that discrimination of pitch is under central control and is dependent on learning through behavioral interaction, in effect saying that learning is the key to the task. Sergeant speculated that it was reasonable to assume that musically trained subjects would score better on pitch discrimination tasks than non-musically trained subjects. In designing the experiment he predicted that if this advanced and more accurate judgment of complex tones over judgment of pure tones was due to learning, then the musicans' discriminatory ability would be even more significant when complex signals rather than pure tones were used.[2] Sergeant ultimately rejected the first hypothesis and concluded that the superior judgment of complex tones was not due entirely to patterns

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[1]Sergeant, pp. 12-14.

[2]Sergeant, p. 13.

of basilar response, and that learning was an important factor in judgment of pitch.

Cuddy's research supported the conclusions reached by Sergeant.[1] Cuddy was concerned with the effect of practice on subjects' ability to identify musical pitches. The report concluded that students with musical backgrounds were more capable of identifying pitches than non-trained subjects. Cuddy's study revealed that students who listed piano as their major instrument identified piano tones more readily than pure tones. Thus, pitch judgment was related to the persons familiarity with the stimulus tone.

Contradicting Sergeant and Cuddy, Leonard reported that timbre was not a significant factor in pitch discrimination.[2] His research attempted to determine the effect of various contextual and intrinsic characteristics of the tone stimulus on pitch discrimination. Leonard examined the characteristics of intensity, timbre, register context, duration, and inter-stimulus time interval on pitch discrimination. The results indicated that all factors studied, except timbre, affected pitch discrimination.

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[1]Lola Lane Cuddy, "Practice Effects in Pitch Perception" (unpublished doctoral dissertation, University of Toronto, 1965), pp. 75-91.

[2]Nels Leonard, Jr., "The Effect of Certain Intrinsic and Contextual Characteristics of the Tone Stimulus on Pitch Discrimination" (unpublished doctoral dissertation, West Virginia University, 1967), pp. 57-74.

In summary, it has been shown that two theories regarding musical talent are prominent. The atomistic view, supported by Seashore, proposes that musicality can be studied through an individual's perception of small changes in the basic properties of a sound stimulus. A conflicting theory advocates a general factor of musicality. Neither theory offers a totally satisfactory explanation of musicality. The atomistic view has come under attack and several studies were discussed that reveal the four properties of sound are perceived in an interdependent, rather than an isolated manner.

Aural Perception of Musical Intervals

The basic properties of musical sounds have been discussed in terms of historical, compositional, acoustical and perceptual developments. Scientific studies demonstrated that the single musical sound is reducable to four component parts. These parts have been examined and research studies presented to show the effects of these sound parameters on different aural perception skills. Further, several writers have shown that the basic units of sound exhibit both psychological and physical characteristics. Lundin indicated that these two characteristics refer to the stimulus side of the pyschological event.[1]

[1] Lundin, pp. 12-13.

Musical intervals also possess various psychological characteristics similar to those of singular sound sources. The interval effect may be defined in the following ways. First, physical dimension may be objectively measured in terms of interval size and mathematical ratio; second, perception is stated in terms of psychological characteristics. For example, the frequencies 440 and 880 can be reduced to the ratio of 1:2 which, when sounded together, produce the psychological sensation of the octave.

Intervals possess a variety of conceptual possibilities with respect to perception. Intervals are said to possess phenomenological descriptions. Qualities which intervals are said to be imbued with include: the fourth sounding rich, the seventh harsh and course; and the second gritty and grating.[1] Additional perceptual possibilities include an apparent single pitch of intervals. This view states that intervals could be spoken of as though each was capable of producing a single tone. The finality effect of certain intervals is claimed as a perceptual attribute of certain combinations.

The perception of root in harmonic intervals was examined by Hurwitz in a study dealing with the phenomenal

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[1] E. M. Edmunds and M. E. Smith, "The Phenomenological Description of Musical Intervals," American Journal of Psychology, XXXIV (1923), pp. 287-291.

testing of musicians toward the perception of interval roots.[1] Hurwitz concluded that loudness, timbre, and context did have effects on the choice of root, however, the overtone series seemed to play a relatively small role in the phenomenal perception of root.

Intervals are described as either consonant or dissonant. In categorizing the twelve simple intervals, individuals are often asked to respond to questions concerning the apparent pleasantness or unpleansantness of the interval effect.[2] The consonance or dissonance discussion was one of the first ways in which psychologists attempted to categorize intervals and the perception of the interval effect. Helmholtz formed his theory of consonance and dissonance in the late nineteenth century. Helmholtz found that when two tones were sounded together and judged consonant, the tones possessed similar overtone patterns. In addition, consonant intervals did not produce the sensation of upper-partial beats. Combinations which did produce the effect of beats were judged to be dissonant and the dissonance was the result of the fundamental or

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[1]Robert Irving Hurwitz, "An Investigation Into the Perception of Root in Harmonic Intervals" (unpublished doctoral dissertation, Indiana University, 1970), pp. 45-59.

[2]Paul R. Farnsworth, The Social Psychology of Music (New York: The Dryden Press, 1958), pp. 33-34.

the upper partials.[1]

Stumpf raised doubt regarding the work of Helmholtz. Stumpf referred to his explanation of the consonance-dissonance question as a theory of fusion or the ability of two clangs to emerge into a single tone. He recognized various degrees of fusion. The octave was regarded as the most consonant, next the perfect fifth. The major third and sixth were also recognized as consonant. The seconds, sevenths, and augmented combinations were near the dissonant end of the category.[2]

Many music psychologists reject both of the above considerations and prefer to speak of the consonance-dissonance perception as essentially a result of inculturation. The consideration of a response to the question of consonance and dissonance being largely influenced by cultural background.[3]

Interval discrimination, being one of the areas basic to much of music perception, has been used widely in music achievement and aptitude tests. Mursell focused

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[1]H. L. F. Helmholtz, On the Sensations of Tone, trans. Alexander Ellis (6th ed.; New York: Peter Smith, 1948), p. 194.

[2]Robert W. Lundin, An Objective Psychology of Music (New York: The Ronald Press Company, 1953), pp. 83-84 citing Carl Stumpf, Tonosychologie (S. Hirzel, Leipzig), I, (1883), and II, (1890).

[3]Farnsworth, p. 193.

attention upon ten factors of musicality.[1] Those ten factors have been employed by various test developers in one manner or another to determine musicality. Included among the ten factors is the skill of interval recognition and reproduction.

Révész has developed a test battery which is useful in testing musical talent. The test contains four sections dealing with rhythmical sense, regional pitch, analysis of two-note combinations and chords, and capacity to grasp and sing melodic lines.[2]

Test developers who have used interval discrimination as partial determinants of musicality are Madison[3], Lundin[4], and Aliferis.[5] Of these music achievement tests, the tests by Lundin and Aliferis contain aural stimuli produced entirely on the piano with no attempt to employ other sound generating sources.

Each interval is perceptually different and has a

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[1]Mursell, p. 303.

[2]Révész, p. 135.

[3]T. H. Madison, "Interval Discrimination as a Measure of Musical Aptitude," Archieves of Psychology, CCVI (1942), pp. 1-99.

[4]R. W. Lundin, "The Development and Validation of a Set of Musical Ability Tests," Psychological Monographs, LXIII, 305 (1949), pp. 1-20.

[5]James Aliferis and J. E. Stecklein, "The Development of a College Entrance Test in Music Achievement," Journal of Research in Music Education, I (Fall, 1953), pp. 83-96.

unique and distinctive quality by which it is perceived. The assumption that an interval should call forth an identical response from all subjects, regardless of training and other influences, is false. Concerning this matter, Farnsworth comments thus:

> . . . interval uniqueness is only one facet in the composite of psychological effects on the listener. The register of the interval, the rate and loudness of its playing, the timbre of the instrument on which it is played, and the melodic and harmonic contours it helps to form all have their part in creating what each listener has learned to want.[1]

Farnsworth further states:

> It is unfortunate that authorities write at times as though a perfect fifth, a minor chord, or a melody will have identical characteristics whether sung or played on a marimba, a harmonica, a tuba, or an old Cremona violin. They are neglecting the differences in timbre.[2]

Musical interval sense has been studied by numerous researchers for the past century. The concept of musical interval sense is defined as the ability to hear a given note and then correctly sing or tune a device to a designated interval above or below the given frequency. In a paper exploring the preciseness of subjects' abilities to judge isolated intervals, Pikler presented a review of

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[1]Farnsworth, p. 44.

[2]Farnsworth, p. 56.

studies in the field.[1] Pikler examined various historical experiments to determine how accurately individuals tuned the asked-for interval after first hearing a given tone. Summarizing the results of experiments in the early portion of the twentieth century, Pikler commented:

> During the first decade and a half of the electronic age, experimental studies on musical interval sense were restricted to the absolute recognition of the different types of musical intervals in multiple choice situations, and to their liminal precision in musical contexts . . . To this day, comparatively little attention has been devoted to the psychophysical problems concerning musical intervals in isolation.[2]

In reviewing experiments of interval identification it was obvious that levels of ability vary greatly. However, the effects of other independent variables such as timbral change on identification skills were seldom studied.

Review of Related Research

Earlier in this chapter it was determined that the sound wave is the most elemental portion of a musical sound. In addition, each sound wave has four characteristic properties: frequency, amplitude, duration, and form. The fourth characteristic, form, is generally

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[1]Andrew Pikler, "History of Experiments on the Musical Interval Sense," Journal of Music Theory, X, 1 (1966), pp. 55-94.

[2]Pikler, pp. 84-85.

referred to as tone quality or timbre.

Studies dealing with timbre can be categorized into two broad areas: timbre recognition and the effects of timbre on pitch perception--high or low. The first area includes studies which attempt to determine the ability of subjects to detect timbral change. The second category of timbre studies deals with the influence of timbre on subjects' ability to judge which of two pitches is higher. Contradictory evidence was presented showing timbre as first affecting, then not affecting the subjects' judgment. The bulk of the evidence seems to support the view that timbre does become a factor in pitch discrimination skills, with the person being able to judge pitch discrimination most accurately when the sound sources are more familiar to him. That is, learning does appear to play a part in pitch discrimination.

An examination into other perception areas and the specific effect of timbral change on those perceptions is sorely lacking. The area involving the influence of timbre on harmonic perception skills appears totally void. Interval identification skill taught in the traditional manner is not concerned, nor influenced, by the factor of timbre if current literature is to be followed.

Aural perception, the ability to perceive sounds and patterns of sounds, is of primary importance to the musician. How best to teach the subject has been a topic of discussion and study for many years. Aural perception is often taught at the collegiate level in the form of ear training courses during the freshman and sophomore years. The bulk of time is spent with the teacher playing selected passages on the piano and the students responding with the appropriate answers. The translative perception skills include harmonic, melodic, and rhythmic dictation, and the like. Many text books simply ignore the effect of timbre on these skills with statements like:

> Any melody possesses at least three basic characteristics: it extends in time . . . it varies in pitch . . . and its individual units . . . possess a certain quality (or timbre). Since this third characteristic of melody varies with the instrument on which a melody is performed, we shall ignore it and concern ourselves exclusively with rhythm and pitch.[1]

The presentation and refinement of aural discrimination skills by traditional methods without reference to factors that have been shown to influence student's aural perception would seem to be consistent with Seashore's writings. Seashore believed that musical talent could be measured through an individual's perception of the physical attributes of the sound wave. Further, he felt that these attributes operate in an independent manner.

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[1]William E. Thomson and Richard P. Delone, Introduction to Ear Training (California: Wadsworth Publishing Co., Inc., 1968), p. 1.

In recent years it has become important to determine what set of conditions may be of influence in the various areas of aural perception. Sergeant discussed several recent findings that conflict with the theories of Seashore:

> The view of these investigations has become increasingly less acceptable because various studies have repeatedly revealed that perceptions of the various parameters of musical sounds are interdependent. Fletcher and Munson, for example, found that loudness perception is dependent on the frequency of the stimulus; Liang and Christovich showed that delta frequency functions were influenced by duration of stimulus; and Saldanha and Corso found perception and recognition of timbre to be subject to stimulus frequency. Irwin claims that pitch, intensity, and duration are all interdependent factors in perception.[1]

The study by Sergeant was concerned with pitch discrimination skill--judging which note was higher, but some of his conclusions lead to a belief that implications exist for other aural discrimination skills. Findings showed that in test situations subjects judged the pitch of complex tones superior to pure tones. Sergeant also found that pitch discrimination is under central control; that is, dependent on learning through behavioral interaction with environmental sound, especially music and speech.[2]

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[1]Sergeant, pp. 3-19.

[2]Sergeant, pp. 12-13.

Jeffries' research into the aural recognition of melodic intervals approached the problem of order of presentation and its effect on subjects' ability to learn basic skills in interval recognition.[1] The researcher was concerned with programmed learning procedures and the teaching method that would prove most effective in melodic interval dictation. Twenty-four subjects, who had no previous training in interval detection, were subjected to a two-week training schedule. Four groups were experimentally devised and interval detection was taught in a different manner to each group. Results of the experiment revealed that drilling the intervals in a random order produced significantly better results than presenting the intervals in the order of increasing difficulty.

Other dissertations and studies have investigated timbre in relation to pitch discrimination--which note is higher, and absolute pitch--naming pitch names without a reference first given. A recent study by Cuddy concluded:

> Musically trained subjects who were studying the piano as a major instrument named piano tones more accurately than pure tones. In general, the accuracy of pitch judgment was related to

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[1]Thomas B. Jeffries, "The Effects of Order of Presentation and Knowledge of Results on the Aural Recognition of Melodic Intervals," Journal of Research in Music Education, XV (Fall, 1967), pp. 179-190.

familiarity with musical tones.[1]

Cuddy's findings tend to support the premise that a person who studies a particular instrument for a period of years develops, or encodes, a sense of pitch judgment for that instrument. This encoding of the instrument's timbre allows judgment of pitch more accurately when the test utilizes that instrumental timbre rather than a pure tone stimulus.

If musically trained subjects were able to identify and respond more accurately when the stimulus was their major instrument, it would seem reasonable that students who had not studied instruments in depth would not be affected by the timbre used. This idea was supported by Leonard.[2] His research was designed to determine the effect of certain intrinsic and contextual characteristics of the tone stimulus on human pitch discrimination. Leonard used six factors and studied their effect on the pitch discrimination skill of subjects who were non-music majors. The experimental variables were intensity, timbre, register context, duration, and inter-stimulus time interval. Leonard indicated that all factors of the tone stimulus involved in the study, except for timbre, significantly affected pitch

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[1]Cuddy, p. 91.

[2]Leonard, pp. 57-74.

discrimination.

The effect of four melodic parameters on subjects ability to make fine-tuning adjustments was undertaken by Swaffield.[1] In the study Swaffield tested the theory that aural perception operates within the framework of contextual influence. The skill under investigation was the ability to tune a tonic pitch after hearing the fourth through seventh degree of the scale in sequence. The variables under investigation were timbre, intensity, duration, and relative frequency. Swaffield concluded that fine-tuning ability in the area of 440 Hz was indeed dependent upon the four variables controlled in the experiment. Further, some instrumental timbres under study were more difficult to tune with accuracy than others. By way of example, Swaffield noted that horn timbre was the easiest to tune accurately and violin the most difficult.

A study by Stecklein and Aliferis grouped music majors into categories and attempted to show how they responded as a group to a music achievement test.[2] Information regarding each student's primary performance

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[1]Swaffield, pp. 305-312.

[2]John Stecklein and James Aliferis, "The Relationship of Instrument to Music Achievement Test Scores," Journal of Research in Music Education, V (Spring, 1957), pp. 3-15.

area and years of study was obtained. Subjects were then placed in one of six groups based on results of the above information. The six groups were composed of students who were experienced in performance of: strings, woodwinds, brass, percussion, piano, and voice. The test to be administered contained three subtests: Melodic, Harmonic, and Rhythmic. The six groups were then ranked according to their mean scores on each of the sections. Results indicated that in the melodic section the string group obtained the highest mean score. In the harmonic section, the piano group scored the highest. In the rhythmic section there were four high scoring groups: woodwinds, brass, percussion, and strings, in that order.

The Stecklein and Aliferis study would seem to indicate that music majors respond differently to various aspects of aural discrimination based on their background and the instrument they regard as their major. The test used the piano as the sound generating source and did not attempt to isolate the effects of timbre.

A study of the influence of several factors on interval identification by Buttram sought to determine what factors might be influencing interval identification.[1]

The four factors chosen for study were interval

[1] Buttram, p. 67.

quale, pitch distance, tonal context, and relative distinctiveness. Buttram's research included a review of literature that was used to support the belief that contextual factors were influencing the subjects' judgment of harmonic intervals. According to Buttram, the literature was largely speculative and no experimental studies were uncovered concerning his specific area of inquiry.

Four hypotheses were constructed to test the significance of the four factors. All four of the null hypotheses were rejected and each factor was found to be significant in judging intervals. The identification of the intervals was not based on any single characteristic, but all factors were found to be of some influence. Careful examination of the test situation revealed that the variable of time was not controlled and Buttram reported that as more time was allowed for response the more accurate the judgment became.

In recommendations listed for further study, Buttram suggested that factors other than the four controlled in his experiment merited further investigation. He cited type and extent of training, instrumental and vocal experience, and different timbres as possible independent variables to be controlled.

[1]Buttram, p. 67.

In conclusion, there is evidence to support the belief that timbre is a factor in the perception of intervals. Studies reveal that timbre is an influence in the perception of pitch. Further, the four basic properties of musical sounds do appear to act in an interdependent manner with regard to perception. One study reported that identification of harmonic intervals was subject to several contextual factors, however timbre was not included as an experimental variable.

Summary

The current chapter reviews research and literature related to the perception and identification of intervals. An historical perspective of the musical interval found the interval to be a basic unit of Western, non-Western and primitive cultures. The evolution of temperament revealed the variability of interval size resulting in the use of several tuning systems during the past several centuries.

Two divergent theories of musicality have affected the development of musical tests and measures, musical aptitude theories, and modes of instruction. The perception of aural stimuli was discussed with reference to the theories of Mursell and Seashore. Neither theory has been accepted as a totally inclusive account of the phenomenon of perception.

In the next section of the review, it was shown that pitch discrimination was affected by the timbre variable. The review of related research disclosed the four parameters of sound; pitch, intensity, duration, and timbre act in an interdependent manner on perceptual skills. Timbre, as a contextual factor, was an influence in certain pitch perception and discrimination skills according to several researchers. They concluded that accuracy of pitch judgment was related to the familiarity of the sound source.

Since timbre was found to affect pitch discrimination, an attempt was made to locate studies concerning the influence of contextual factors on interval identification. One study in the area indicated that the factors of interval quale, pitch distance, tonal context, and relative distinctiveness were influential in the skill of interval identification. The review of literature and related research did not disclose studies directly related to the effect of timbre on the perception of musical intervals.

CHAPTER III

METHODS AND PROCEDURES

Collegiate musicians from selected Oklahoma colleges and universities acted as subjects in determining the effect of instrumental timbre and previous experience gained through the primary performance medium on the perception and identification of musical intervals. In selecting the subjects to be included in the experiment an investigator-developed Test of Interval Identification was administered to four hundred-one (n=401) band members and students from selected music classes at the participating schools. On the basis of the administration of the interval identification measure and completion of a Biographical Information Questionnaire, potential subjects were classified according to their major performance medium. From this pool, subjects were further screened to insure completion of at least one semester of music theory, or its equivalent, and scoring at or above the mean on a experience scale for their respective instruments. From the population of subjects not excluded from further consideration by means of this process, eighty (n=80) were randomly selected and placed in four equal timbral groups, (n=20), and classified as Clarinetists, Trumpeters, Pianists, and Other Instrumentalists.

A Test of Interval Identification, composed of five timbral subtests, was developed for use in the experiment. Selected musical intervals were recorded in random arrangement using the clarinet, trumpet, piano, french horn and flute in combination, and an oscillator as the sound sources. Students' responses to the Test of Interval Identification were used to investigate the effect of timbre on interval identification skills. In addition, mean scores were examined to determine whether the various instrumental groups' aural perception and identification skills were enhanced when the musical intervals were sounded by the subjects' primary performance medium. Subjects were asked to identify seventy-five (75) recorded musical intervals produced by the five sound sources.

Research Design

The research design chosen for the present experiment was a multiple-sample experimental design preceded by the random sampling of participants from four (4) finite populations.[1] A paradigm of this research design is presented in Figure 2.

Experimental Subjects

The population consisted of some four hundred-one (n=401) undergraduate instrumental musicians enrolled in

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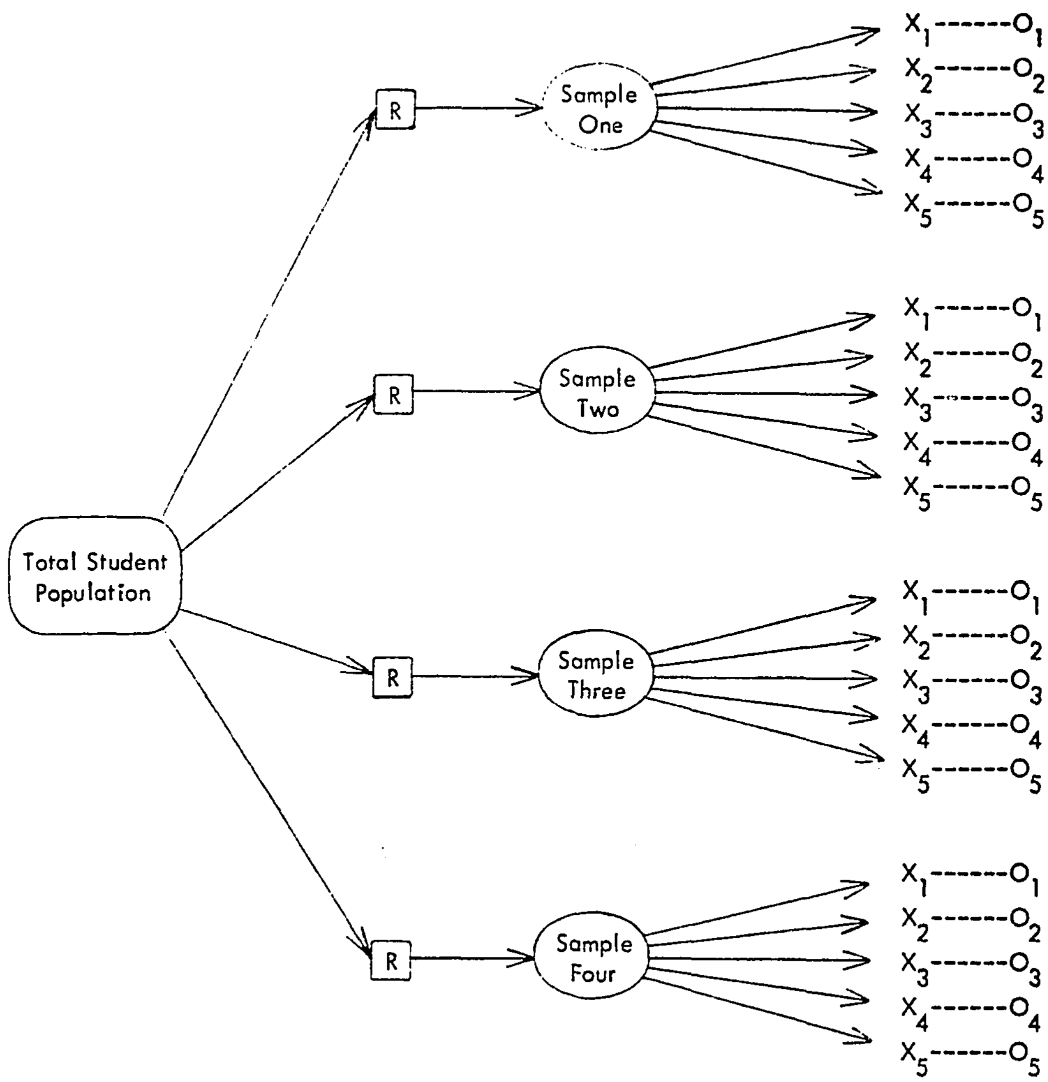
[1]Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research (New York: Rand McNally Co., 1963), p. 51.



$\boxed{R}$ = Random selection of students from the parent population

X_n = Experimental Treatments; subtests from the <u>Test of Interval Identification</u>

O_n = Observations; students' responses to the five timbral subtests.

Figure 2. Illustration of Research Design Used in Conducting the Study

eight colleges and universities in Oklahoma during the fall or spring term of the 1975-76 academic year. A letter was sent to the instrumental music directors of the respective schools to solicit their support. Prior to the test administration, subjects in the university band at the participating institutions completed the Biographical Information Questionnaire. For reference, a facsimile letter and questionnaire are included in Appendix A, and Appendix B, respectively.

Early in the study it became apparent that a sufficient number of pianists would not be obtained from the participating bands. Therefore, additional pianists were obtained from selected music courses at the same institutions. Prior to testing, the pianists completed the Biographical Information Questionnaire. The overall student population consisted of subjects from the participating bands and additional pianists selected from music courses.

The students included in the experiment were grouped on the basis of previous musical experience on the specified instruments and completion of at least one semester of music theory or its equivalent. The specific criteria for subjects in each of the four instrumental groups is shown in Table 2.

Table 2. Criteria Used for Placing Students in the Four Sample Instrumental Groups

Instrumental Group	Criteria for Selection
PIANISTS	Students who scored above the 50th percentile on the Experience Scale* for Pianists Students who had completed at least one semester of music theory, or its equivalent
CLARINETISTS	Students who scored above the 50th percentile on the Experience Scale* for Clarinetists Students who had completed at least one semester of music theory, or its equivalent
TRUMPETERS	Students who scored above the 50th percentile on the Experience Scale* for Trumpeters Students who had completed at least one semester of music theory, or its equivalent
OTHER INSTRUMENTALISTS	Students who were music majors but who did not list clarinet, trumpet, or piano as their major instrument Students who scored above the 50th percentile on the Experience Scale* for the other miscellaneous instruments listed Students who had completed at least one semester of music theory, or its equivalent

*The "Experience Scale" is defined as the number of years the respondent had played and/or studied a particular musical instrument. This information was reported on the upper portion of the students' Answer Sheet.

Development of a Test of Interval Identification

An investigator-developed test of interval identification was designed for use in the study. After several modifications, the instrument was divided into five subtests, each employing timbral change as the independent variable. Each subtest contained fifteen simple intervals, randomized by established criteria.[1] More specifically, the timbral subtests contained twelve simple intervals plus three intervals that were repeated but on different pitches. All factors were held constant except the independent variable, timbre. The instrumental timbres employed in the subtests were: (1) clarinet, (2) trumpet, (3) piano, (4) a mixed timbre utilizing french horn and flute, and, (5) pure tone produced by means of an oscillator.

The clarinet was selected for inclusion in the experiment because its characteristic timbre results primarily from a predominance of odd numbered partials[2] and because the clarinet is representative of the woodwind family of musical instruments.

The trumpet was chosen because its characteristic timbre is partly the result of a uniformity of the

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[1]Criteria employed in the interval randomization procedure are described on pages 56-57.

[2]C. A. Taylor, The Physics of Musical Sounds (New York: American Elseview Publishing Co., Inc., 1965), p. 163.

overtones, except the first partial which is comparatively weak in the lower range,[1] and because it is representative of the brass family of musical instruments.

The piano was chosen because many ear training courses and several standardized tests of interval identification use the piano as a source for generating musical intervals.

The french horn and flute were chosen to represent a mixed timbre created by one woodwind and one brass instrument. Both instruments are representative of their respective families and were not selected previously for inclusion in the subtests. All subtests, except the flute and horn version, contained intervals produced by instruments with the same timbral quality.

An oscillator was chosen because of its ability to produce a pure sine wave. While the pure tone is considered by some to be an undesirable sound source for studies dealing with aural acuity,[2] a tone which is free of overtones and not normally produced by the familiar musical instruments was felt necessary to test one of the stated hypotheses. This Pure Tone subtest served as a control variable in the experiment.

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[1]Carl E. Seashore, Psychology of Music (New York: McGraw-Hill Book Company, Inc., 1937), p. 188.

[2]Desmond Sergeant, "Measurement of Pitch Discrimination," Journal of Research in Music Education, XXI (Spring, 1973), p. 11.

Selection of Intervals

Since the trumpet has the most narrow practical range, the ranges of the other four sound sources were limited to the range characteristic of the trumpet. Due to range, certain exceptions were made in the Flute and Horn subtest. The trumpet range was established as extending from concert E, below middle C, to B flat above the treble staff.

A great number of combinations are possible when both simple and compound intervals are available. Since all compound intervals are reducable to the twelve simple intervals contained within the span of an octave, it was determined that the musical intervals selected for use in the experiment would include only the twelve intervals within the octave.

The first step was the random selection and assignment of intervals to the subtest containing the pure tone. Each of the twelve simple intervals was drawn at random and assigned a position on the timbral subtest using a pure tone. For example, the first interval selected at random was assigned as the first presentation on the Pure Tone subtest. After the original twelve simple intervals were selected, three more intervals were drawn at random and assigned positions thirteen, fourteen, and fifteen. No attempt was made at this stage to assign specific pitches, only interval size. Two additional variables were randomized for further control and included; the possible pitch of the lower note, and octave placement of the selected interval.

The final organization of intervals on the Pure Tone subtest was determined by randomizing each of the three variables. For example, the first interval selected in the Pure Tone subtest was a minor second, having a lower pitch of F#, and octave placement of $F\#^2$. Random procedures were followed until the first twelve intervals in the Pure Tone subtest had been selected and recorded. The final three intervals were selected separately but similar procedures were followed in placing them within each timbral subtest.

In the remaining four timbral subtests each interval began on the same pitch and had the same octave placement. For example, the fifth interval on the Piano subtest was a minor second, having a lower pitch of F#, and octave placement of $F\#^2$. This interval was the first sounded on the Pure Tone subtest. The only changes occuring were in the random order of presentation and the different timbre used. The intervals chosen for the five timbral subtests are shown in Appendix C.

Equipment Used to Record the Intervals

The following electronic and recording equipment was selected for use in the experiment:

Oscillator. For the experimental subtest involving the use of pure tones, two oscillators were required. Selected equipment was the Krohn-Hite Audio Oscillator (Model 400-A) and the Heathkit Audio Oscillator (Model G-2). Both models were capable of producing sine and square waves. For this experiment the sine wave was used.

Mixer. A Sony 6-channel stereo microphone mixer (Model MX-12) was used to transmit the signal from the oscillators to the tape recorder. The oscillators were pretuned to the required frequencies and by use of the mixer switch both tones of the interval began at the same time.

Amplifier. A Kenwood Solid State Amplifier (Model KA 4002) was used to provide the needed amplification for all five of the timbral subtests.

Microphones. The microphones utilized in the recording process included a Sennheiser MD 421 LL and a Shure SM61. The Sennheiser microphone provided transmission of the sound for two of the subtests; Clarinet, and Trumpet. The Shure microphone provided better sound transmission of the Piano subtest because of its omnidirectional pattern.

Tape deck. A Sony TC 366 solid state tape deck was used to record all the experimental intervals.

Speakers. Two Advent speakers were used to judge the quality of the original taped experimental subtests. In addition, the same two speakers were used to transmit the completed Test of Interval Identification to the experimental subjects.

Tapes. All experimental subtests were stored on TDK Audua high output-low noise, l.ml., recording tape. Final master tapes for use in the experiment were of the same type and quality.

Establishing the Validity of the Test of Interval Identification

A certain amount of validity was assumed for the instrument since all intervals contained within the octave were included in the Test of Interval Identification. However, it was necessary to further establish the validity of the instrument, directions for administration, and the response form. This was accomplished by submitting the materials developed to a panel for scrutiny. The panel included the following persons: (1) five music professors, (2) a research psychologist, and (3) the Chairman of the Doctoral Committee. The suggestions made by this group were incorporated into the instrument as appropriate. After all suggested changes, additions, or deletions had been made to the satisfaction of the panel, they were asked to determine the content validity of the testing instrument, and the clarity and precision of the directions for administration. In particular, the members of the panel were asked to attest to the instrument's ability to measure the skill of interval identification. The professors further attested to the representativeness of the timbres produced by each of the sound sources. The individuals who served as consultants in establishing the validity of the instrument are provided in Appendix I.

Establishing the Reliability of the Test of Interval Identification

The test-retest reliability of the Test of Interval Identification was established by conducting a pilot study. The pilot study utilized thirty-six (n=36) undergraduate music students enrolled in sophomore theory courses at Oklahoma Baptist University, Shawnee, Oklahoma during the 1975 fall term. The test-retest interval was two weeks. A Pearson Product-Moment Correlation was used to compare the students' responses on the two administrations of the test. The test-retest reliability ranged from a high of .988 for the Trumpet subtest to a low of .934 for the Piano subtest. The overall test-retest reliability was determined to be .974.

Pilot Study

As previously mentioned, a pilot study was conducted after the Test of Interval Identification had been developed. The primary purpose of the pilot study was to identify and correct any problems with either the testing instrument, ancillary materials or the actual testing procedures. More specifically, the pilot study served the following purposes: (1) The pilot study allowed the researcher to identify problems with the tapes such as poor recording quality or response time difficulties. (2) The pilot study helped to identify deficiencies in the response form, and the Biographical Information Questionnaire. (3) Results from the Biographical Information Questionnaire gave some indication of any difficulties in forming the four instrumental groups. (4) The pilot study allowed the researcher to identify and correct any problems in scoring the response forms and the ensuing data analysis.

Results of the pilot study were used to make corrections, additions, or deletions needed to improve the Test of Interval Identification, the directions for administration, and the response form. In addition, data collected were used to establish the reliability of the test.

Administering the Test of Interval Identification

The Test of Interval Identification was administered to all participants from each institution at a single sitting. However, additional testing sessions were conducted at two universities because it was not possible to assemble all participants for a single sitting. In addition, a separate group of pianists were obtained from selected music courses at one university because it seemed unlikely the pianists' group would not be filled from subjects in the participating organizations. All testing was accomplished within a span of seven weeks. The selected institutions and dates of test administration are shown in Appendix J.

Experimental Procedures

The instructions which accompany the Test of Interval Identification were pre-recorded on the tapes containing the aural examples of the musical intervals (Appendix E). However, the preliminary instructions needed to complete the first part of the response form were given orally by the experimenter. Participants were allowed five minutes to complete the Biographical Information Questionnaire and the first part of the response form (Appendix F). As soon as the examinees had completed the first part of the response form, the first portion of the directions was played.

The tape was stopped after the directions and five practice items had been given. Additional instructions or explanations were given as necessary to insure proper understanding of the tasks to be performed. For reference, the five practice intervals are reproduced in Appendix G.

When all questions had been answered, the tape containing the 75 pre-recorded musical intervals was begun. At the conclusion of each subtest the subjects were informed of the instrumental timbre of the next subtest. Each interval was preceded by the oral numbering of the interval to be played. For example, the first interval was preceded by a voice saying "number one," this was followed immediately by a four-second presentation of the musical interval. The sounding of the interval was followed by an eight-second pause to allow the students to respond. At the end of the response time, a pre-recorded voice said, "number two." This was followed by the sounding of the musical interval and the eight-second response period. The time and instruction sequence for each musical interval was as follows:

1. Numbering of the interval to be played.
2. Four-second sound presentation of the musical interval.
3. Eight-second silence allowing students time to respond.

Identical procedures were followed during each administration of the <u>Test of Interval Identification</u>. However, the five subtests were rotated via a Latin Squares Rotation Design. This procedure controlled any practice effects which might occur.[1] The process was expedited by preparing one master tape with a single set of instructions. All subjects heard the same set of instructions. Following the instructions, the tape was moved to the appropriate starting timbral subtest for each school. The order of presentation of the five subtests was

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[1]Campbell and Stanley, p. 52.

rotated at each site. The orders of presentation were as follows:

Presentation 1: Piano, Pure Tone, Clarinet, Flute and Horn, and Trumpet

Presentation 2: Pure Tone, Clarinet, Flute and Horn, Trumpet, and Piano

Presentation 3: Clarinet, Flute and Horn, Trumpet, Piano, and Pure Tone

Presentation 4: Flute and Horn, Trumpet, Piano, Pure Tone, and Clarinet

Presentation 5: Trumpet, Piano, Pure Tone, Clarinet, and Flute and Horn

As soon as the last musical interval on the final subtest had been sounded and the students had been allowed to respond, the tape was stopped and response forms collected. Participants were not allowed to go back and check their responses, and no musical intervals were sounded again. When these test administration procedures had been concluded at each university, the experimental procedures were complete.

For additional information concerning the study, the tape recorded test and instructions are available and located at the University of Oklahoma, School of Music Listening Laboratory, Norman, Oklahoma.

Preliminary Analysis Procedures

The first step in the analysis procedure was the elimination of those respondents who did not meet the criteria established for participation in the study.

Subjects were eliminated who did not properly complete the interval identification test; those who did not list a major instrument; gave no indication of the amount of time they had spent studying or playing an instrument; and those who had not completed at least one semester of music theory, or its equivalent.

The four instrumental groups were formed as follows: (1) Clarinetists, (2) Trumpeters, (3) Pianists, and (4) Other Instrumentalists. After these four groups had been formed, the mean years of playing experience was determined for each classification. Subjects whose playing experience on the selected instruments was equal to or above the mean number of years for each group were considered to have met the minimum criteria for inclusion in the study.

From the population of subjects not excluded from further consideration by means of this process, eighty (n=80) were randomly selected and placed in four equal timbral groups. However, as the Pianists group did not contain a total of twenty subjects whose number of years of study was above the mean, one student whose experience fell below the mean was included to obtain the required twenty subjects for the Pianists.

The responses of those participants chosen for the statistical comparisons were scored. Each student made seventy-five (75) responses on the response form. A raw score ranging from 0-15 was calculated for subjects on each of the five subtests. All data were placed on IBM cards as a means of expediting the statistical analysis and improving the accuracy of the results.

Statistical Treatment of the Data

The data analysis procedures consisted of the statistical treatment of the data and the testing of the hypotheses relating to the major purpose of the study. The five sets of raw scores from the timbral subtests were calculated for each group. The data analysis consisted of computing the appropriate measures of central tendency and dispersion.

Two null hypotheses were tested by means of a two-factor analysis of variance for repeated measures; a third null hypothesis was tested by means of a series of one-way analysis of variance classifications. Significant F-ratios obtained through the factorial analysis were studied by means of studentized range statistics for the purpose of locating specific mean differences among the four instrumental groups and five timbral subtests. The *Newman-Keuls Test* was the range statistic used in the *post hoc* comparisons.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The present study represents an attempt to determine the effect of timbre on the interval identification skills of collegiate musicians. In the study, eighty collegiate musicians from selected colleges and universities in Oklahoma acted as subjects in a study to determine the effects of instrumental timbre on participants' skills in perceiving and identifying musical intervals. Pianists, Clarinetists, Trumpeters, and Other Instrumentalists*, were selected by established criteria and placed in four equal timbral groups, (n=20). The instrumental groups were administered an investigator-developed Test of Interval Identification which contained five timbral subtests: Piano, Pure Tone, Clarinet, Flute and Horn, and Trumpet. Each subtest was composed of fifteen pre-recorded equivalent musical intervals. Participants' correct responses to subtest intervals were used to test the null hypotheses relating to the major purpose of the study. This chapter presents the data, their analysis and related findings.

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*Other Instrumentalists were all those study participants who were not pianists, clarinetists, or trumpeters.

Preliminary Analysis

The first step in the preliminary analysis was to compute the descriptive statistics for the participants' scores on the five timbral subtests of the interval identification measure. Mean interval identification scores and standard deviations for each instrumental group and timbral subtest are presented in Table 3. The raw data are contained in Tables 14 through 17 in Appendix H.

Table 3. Means and Standard Deviations for Each Instrumental Group

Instrument Subtests	Pianists	Clarinetists	Trumpeters	Other Instrumental
Piano Subtest	$\bar{X}$ = 11.60	$\bar{X}$ = 6.75	$\bar{X}$ = 8.70	$\bar{X}$ = 8.90
	S = 3.338	S = 3.753	S = 3.523	S = 2.577
Pure Tone Subtest	$\bar{X}$ = 11.45	$\bar{X}$ = 6.75	$\bar{X}$ = 8.35	$\bar{X}$ = 8.60
	S = 3.708	S = 3.238	S = 5.82	S = 3.200
Clarinet Subtest	$\bar{X}$ = 11.45	$\bar{X}$ = 6.85	$\bar{X}$ = 9.20	$\bar{X}$ = 8.85
	S = 3.667	S = 4.707	S = 3.187	S = 2.937
Flute and Horn Subtest	$\bar{X}$ = 10.95	$\bar{X}$ = 6.30	$\bar{X}$ = 8.20	$\bar{X}$ = 8.00
	S = 3.89	S = 3.61	S = 4.02	S = 4.06
Trumpet Subtest	$\bar{X}$ = 11.35	$\bar{X}$ = 7.70	$\bar{X}$ = 9.20	$\bar{X}$ = 8.20
	S = 3.454	S = 3.607	S = 3.480	S = 3.140

To determine whether the variances were statistically equal, a primary assumption of an analysis of variance testing statistic,[1] variances of the instrumental groups and timbral subtests were compared by means of an F-Maximum Test for Homogeneity of Sample Variances.[2] The results showed that the sample variances did not differ significantly, thus supporting the assumption of homogeneity.

Analysis of the Data

The first and second null hypotheses of the study stated, respectively, that there would be no difference in the mean interval identification scores of subjects grouped according to major instrument classification; and there would be no difference in the mean interval identification scores on the five subtests of the interval identification measure. A subquestion concerned with the interaction between the four instrumental groups and five timbral subtests also was investigated.

To test the two null hypotheses and investigate the related subquestion, a two-factor analysis of variance for repeated measures was used. The statistical

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[1]William L. Hays, Statistics (New York: Holt, Rinehart, and Winston, 1963), pp. 408-410.

[2]James L. Bruning and B. L. Kintz, Computational Handbook of Statistics (Illinois: Scott, Foresman, and Co., 1968), p. 110.

summary pertinent to the data analysis and related subquestion is presented in Table 4.

Table 4. Analysis of Variance Comparing the Four Groups' Total Scores and Scores from the Five Subtests

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance Level
BETWEEN					
Instrumental Groups (A)	1,035.21	3	345.07	6.031	0.0013
Subjects Within Groups	4,348.72	76	57.22		
WITHIN					
Instrument Subtests (B)	30.24	4	7.56	3.176	0.0141
Interaction (A x B)	24.96	12	2.08	0.858	0.5914
B x Subjects Within Groups (Error)	725.42	304	2.39		
TOTAL	6,164.55	399	15.45		

Main Effect: Instrumental Groups

As noted in Table 4, the obtained F-ratio of 6.031 exceeded the critical value for F at the .001 level. The null hypothesis relating to mean achievement differences for subjects grouped according to major instrument classification was thus rejected.

Findings: Instrumental Groups. Mean achievement scores for subjects grouped according to major instrument classification on the interval identification measure varied from 11.36 for Pianists to 6.87 for Clarinetists. As disclosed by the Newman-Keuls Test for post hoc comparisons, the Piano group obtained significantly higher mean achievement scores than their counterparts. A summary of the Newman-Keuls Test data is provided in Table 5.

Table 5. Summary Table of Comparisons Made Among the Instrumental Groups' Total Scores

Rank-Ordered mean Values		Clarinetists	Other Instru-mentalists	Trumpeters	Pianists
Clarinetists' Average Total Score	$\overline{X}_2 = 34.35$	----	8.20	9.25	22.45***
Other Instrumentalists' Average Total Score	$\overline{X}_4 = 42.55$		----	1.05	14.25**
Trumpeters' Average Total Score	$\overline{X}_3 = 43.60$			----	13.20**
Pianists' Average Total Score	$\overline{X}_1 = 56.80$				----

$MS_{Error} = 57.23$

***Significant beyond the .001 level
**Significant Beyond the .01 level

The analysis supports the contention that the major performance medium is a factor in the interval perception and identification process. For reference, means and standard deviations for each instrumental group classification are provided in Table 6.

Table 6. Instrumental Groups' Means and Standard Deviations

Group	Average Score (Mean)	Standard Deviation
Clarinetists	6.870	3.648
Other Instrumentalists	8.510	3.240
Trumpeters	8.720	3.593
Pianists	11.360	3.624

Main Effect: Timbral Subtests

The obtained F-ratio of 3.176 for the timbral subtests exceeded the critical value for F at the .01 level. The null hypothesis related to the question of timbral source as a factor in the interval perception and identification ability of subjects was rejected. A summary of these data is provided in Table 4.

Findings: Timbral Subtests. The analysis disclosed a significant difference in the subjects' ability to perceive and identify subtest intervals as a result of timbral manipulation. As noted in Table 7, post hoc comparisons utilizing the Newman-Keuls Test disclosed significantly fewer correct responses for the Flute and Horn timbral combination than for the other four timbres.

The percentage of correct responses for each of the five timbral subtests is provided in Table 8.

Table 7. Comparisons Made Among the Average Number of Correct Responses to the Five Subtests

Rank-Ordered Mean Values		Flute and Horn Subtest	Pure Tone Subtest	Piano Subtest	Clarinet Subtest	Trumpet Subtest
Average Score on the Flute and Horn Subtest	$\bar{X}_4 = 8.363$	----	0.425*	0.625*	0.725**	0.738**
Average Score on the Pure Tone Subtest	$\bar{X}_2 = 8.788$		----	0.200	0.300	0.313
Average Score on the Piano Subtest	$\bar{X}_1 = 8.988$			----	0.100	0.113
Average Score on the Clarinet Subtest	$\bar{X}_3 = 9.088$				----	0.013
Average Score on the Trumpet Subtest	$\bar{X}_5 = 9.100$					----

$MS_{Error} = 2.382$

**Significant Beyond the .01 Level
*Significant Beyond the .05 Level

Table 8. Percentage of Correct Responses for Each of the Five Timbral Subtests

Piano Subtest	Pure Tone Subtest	Clarinet Subtest	Flute and Horn Subtest	Trumpet Subtest
59.93%	58.60%	60.60%	55.73%*	60.67%

*Significant at the .01 level

Interaction Effect and Findings

Concerning the subquestion of instrumental group classification and timbral subtests interaction, the obtained F-ratio of 0.858 was not significant. A graphic representation of the interaction effect is presented in Figure 3.

Analysis of Instrumental Group Classification Scores on Timbral Subtests

The third null hypothesis stated that there would be no difference in the mean scores of the instrumental groups on the five timbral subtests of the interval identification measure. The data were tested by a one-way analysis of variance. The obtained F-ratios for each instrumental group were as follows: Pianists, F = 0.084; Clarinetists, F = 0.373; Trumpeters, F = 0.329; and Other Instrumentalists, F = 0.290; and were less than the critical value for F, with appropriate adjustments in degrees of freedom.

Findings. Group performance on each timbral subtest did not vary beyond that expected by chance. The data do not support the contention that interval perception and identification ability is enhanced when the generating sound is produced by an instrument the subjects regard as their primary performance medium. For reference, these data are summarized in Tables 9-12.

Ancillary Findings

One of the ancillary findings of the present study was related to the usefulness of the five timbral sources for testing subjects' interval identification skills. To

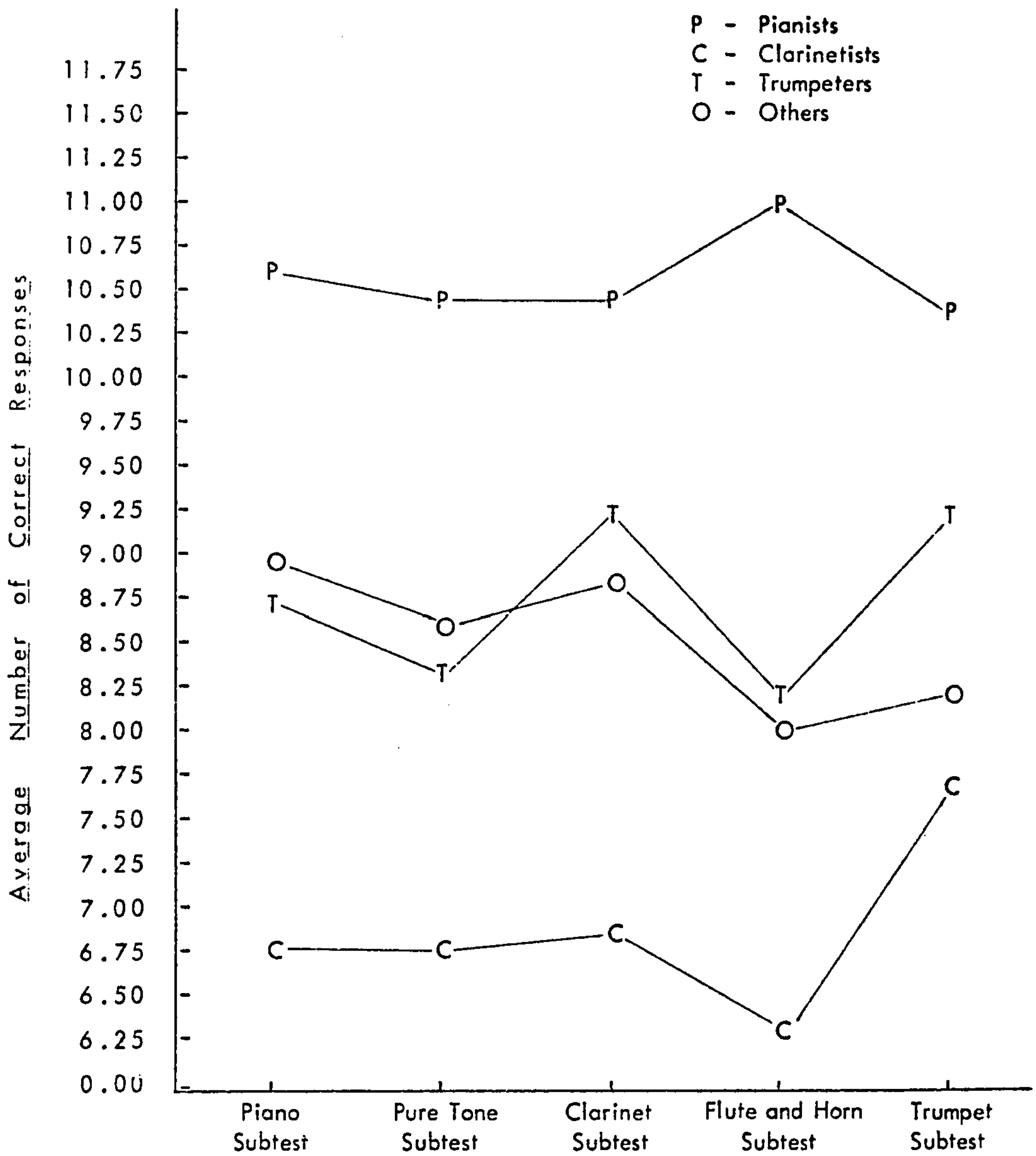

Figure 3. Interaction Between the Four Instrumental Groups and the Five Timbral Subtests

Table 9. Analysis of Variance of Mean Timbral Subtest Scores for Pianists

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio
Between Subtests	4.65	4	1.16	0.084
Within Subjects	1,304.35	95	13.73	
TOTAL	1,309.00	99		

Table 10. Analysis of Variance of Mean Timbral Subtest Scores for Clarinetists

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio
Between Subtests	20.55	4	5.14	0.373
Within Subjects	1,310.45	95	13.79	
TOTAL	1,331.00	99		

Table 11. Analysis of Variance of Mean Timbral Subtest Scores for Trumpeters

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio
Between Subtests	17.65	4	4.413	0.329
Within Subjects	1,273.35	95	13.400	
TOTAL	1,291.00	99		

Table 12. Analysis of Variance of Mean Timbral Subtest Scores for Other Instrumentalists

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Ratio
Between Subtests	12.65	4	3.163	0.290
Within Subjects	1,037.35	95	10.920	
TOTAL	1,050.00	99		

determine the level of appropriateness of each timbre used in the study, numerical values were assigned to the rank ordered means of each instrumental group's subtest scores. Highest subtest means were assigned a value of five (5), second highest were assigned a value of four (4), and so on until the lowest mean was assigned a value of one (1). These assigned values were then summed to determine the overall appropriateness of each particular timbre as a medium for harmonic interval production. The results of these procedures are presented in Table 13.

Table 13. The Appropriateness of each Sound Source for Generating the Harmonic Intervals

	Sound Sources Used to Generate Intervals				
Instrumental Groups	Piano	Pure Tone	Clarinet	Flute and Horn	Trumpet
Pianists	5*	3*	4*	1*	2*
Clarinetists	2	3	4	1	5
Trumpeters	3	2	5	1	4
Other Instrumentalists	5	3	4	1	2
"Appropriateness" Indices . . .	15	11	17	4	13

*5 = Numerical value assigned to the highest subtest mean
*4 = Numerical value assigned to the second highest subtest mean
*3 = Numerical value assigned to the third highest subtest mean
*2 = Numerical value assigned to the fourth highest subtest mean
*1 = Numerical value assigned to the lowest subtest mean

The results presented in Table 13 show that the Clarinet subtest received the highest index (17). This was followed by the Piano subtest (15), Trumpet subtest (13), Pure Tone subtest (11), and the Flute and Horn subtest (4) which ranked as the timbral source generating the lowest mean scores for the various instrumental groups.

CHAPTER V

SUMMARY AND CONCLUSIONS

Introduction

The aural perception of vertical sonorities has been a topic of study for many years. Early research in the area by Helmholtz served as a foundation for further investigations in the early twentieth century by Mursell and Seashore. Although Mursell and Seashore approached the problem from opposing psychological viewpoints, both were instrumental in articulating concepts concerning musicality. Contemporary thought reveals that aural perception skills can be influenced by training, experience, and contextual factors. An examination of literature dealing with interval identification shows that the effect of the contextual factor, timbre, has not received sufficient attention. Thus, the need for additional information gained through a study of the specific effect of timbre on the perception and identification of musical intervals formed the basis for the present study.

Purpose of the Study

The present study represents an attempt to determine the effect of timbre on selected interval identification skills of collegiate music majors. More specifically, the study was concerned with the ability of collegiate music majors to perceive and identify intervals as a function of timbral experience gained through the primary performance medium.

Experimental Procedures

The experiment involved music students from eight selected colleges and universities located in Oklahoma. The participating schools were selected on the basis of their proximity to the University of Oklahoma, Norman, Oklahoma and the number of students enrolled in music and music education degree programs. In selecting the subjects to be included in the experiment, an investigator-developed <u>Test of Interval Identification</u> composed of five separate timbral subtests sounding common musical intervals by means of distinct tone colors, was administered to some 400 band members and students from selected music classes at the participating schools. On the basis of the administration of the interval identification measure and completion of a <u>Biographical Information Questionnaire</u>, potential subjects were classified according to their major performance medium. From this pool, subjects were further screened to insure completion of at least one semester of music theory, or its equivalent, and scoring at or above the mean on an experience scale[1] for their respective

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[1]The experience scale was a criterion item on the <u>Biographical Information Questionnaire</u>.

instruments. From the population of subjects not excluded from further consideration by means of this process, 80 were randomly selected and placed in four equal timbral groups, (n=20), and classified as Clarinetists, Trumpeters, Pianists, and Other Instrumentalists.

The performance of each instrumental classification group on the interval identification measure was organized on the basis of total mean and subtest scores which were utilized in the testing of the several hypotheses relating to the major purpose of the study.

Test of Interval Identification

An investigator-developed Test of Interval Identification was the criterion measure employed in the experiment. The tape recorded interval identification measure was designed to provide information concerning the effect of timbre on the instrumentalists' interval identification skills.

The instrument consists of five subtests, each utilizing a different timbre to generate the musical intervals. The timbres represented include piano, pure tone, clarinet, flute and horn in combination, and trumpet. The clarinet, trumpet, and piano were selected for inclusion in the experiment because each instrument posseses a distinctive tone quality and served as a representative of its respective instrument family. The flute and french horn were chosen to represent a mixed timbre created by one woodwind and one brass instrument. The pure tone was selected to represent a timbre not normally produced by the familiar musical instruments and served as a control variable in the experiment.

Fifteen vertically-sounded intervals were presented on each subtest. The intervals consisted of the twelve simple intervals contained within the octave plus three selected for repetition on other pitches. Three variables were controlled in the interval selection process including the randomized order of presentation, the possible pitch of the lower note, and the octave placement of the selected interval. The interval selection process was initially used to construct intervals in the Pure Tone subtest. The intervals contained within the remaining subtests were organized by the same selection process with timbral change serving as the independent variable. While the same intervals were used in each subtest, their order of presentation was varied.

The _Test of Interval Identification_ was assumed to possess a certain amount of validity since all intervals studied were contained within each timbral subtest. In addition, the measure was submitted to a panel for their examination. The panel was asked to determine the content validity of the measure. They were further asked to attest to the instrument's ability to measure interval identification skill. Suggestions were incorporated in the instrument when possible, and a final version was constructed and re-examined by the panel.

The test-retest reliability of the instrument was established by a pilot study utilizing 36 students from Oklahoma Baptist University. The overall test-retest reliability was determined to be 0.974. In addition, the purpose of the pilot study was to identify and correct problems with the actual testing procedures.

For additional information concerning the study, the tape recorded test and instructions are available and located at the University of Oklahoma, School of Music Listening Laboratory, Norman, Oklahoma.

Findings

The first null hypothesis of the study, which stated that the mean interval identification scores of subjects grouped according to primary performance medium would be equal, was tested by a two-factor analysis of variance. The analysis resulted in the rejection of the null hypothesis, as the interval identification scores of the Pianists were significantly higher than their counterparts in the other groups.

The testing of the second null hypothesis of the study, which stated that the mean interval identification scores of the five timbral subtests would be equal, revealed that timbre was a significant factor in interval identification skills. The timbral subtest employing the flute and horn in combination was found to yield significantly lower mean scores. The null hypothesis was thus rejected.

The interaction of instrumental groups with timbral subtest scores did not produce results that could be differentiated from chance.

The third null hypothesis of the study, which stated that subjects' scores on the timbral subtest containing intervals produced by their primary performing instrument and the remaining subtests would be equal, was tested by a series of one-way analysis of variance classifications, and resulted in the retention of the null hypothesis. Scores from the five timbral subtests were not significantly different when the intervals were sounded by the subjects' primary performance medium.

Ancillary findings showed that the Clarinet subtest yielded the highest interval identification scores when all instrumental groups were considered. The timbral subtest utilizing the flute and horn in combination was determined to be the most difficult medium for perceiving the intervals.

Conclusions

The findings presented in Chapter IV support two of the three major hypotheses under investigation. The conclusions drawn from these results are presented in this section of the present chapter.

1. Participants' overall ability to perceive and identify vertically-sounded intervals is related, in part, to experience gained through the primary performance medium. Results indicated that the Pianists were more proficient at interval identification than the three other instrumental groups regardless of the timbral source used to sound the intervals. As an observation, it can be noted that Clarinetists were less proficient at interval identification than their counterparts in the other groups.

Consistent with the findings of previous research,[1] the Pianists were found to perceive and identify vertical sonorities more accurately than other classification groups. The writer speculates that the acoustical nature of the instruments utilized in the study and pedagogical practices employed in teaching these instruments were factors contributing to this outcome. Brass players, for example, begin study by exploration of the natural harmonic series of the instrument. Clarinetists, in contrast, deal primarily with fingering patterns. The pianists, by nature of the instrument, deal with vertical sonorities early in the instruction process.

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[1]John Stecklein and James Aliferis, "The Relationship of Instrument to Music Achievement Test Scores," Journal of Research in Music Education, V (Spring, 1957), pp. 3-15.

2. Timbre is a significant variable in the perception and identification of harmonic musical intervals as determined by the experimental procedures utilized in the study. Participants scored significantly lower when intervals were sounded by the flute and horn in combination than when sounded by other timbral sources.

Related research[1,2,3,4] supporting the view that aural discrimination skills, in general, are subject to contextual factors is given additional support by the findings of the present study. In view of the increasing amount of research dealing with the influence of contextual factors on the development of aural acuity, little attention referenced to recent findings has been devoted to curricular practices and textbooks at the collegiate level.

3. The perception and identification of musical intervals was not enhanced when the intervals were sounded by the participants' primary performance medium. Subjects'

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[1]Paul A. Haack, "The Influence of Loudness on the Discrimination of Musical Sound Factors," Journal of Research in Music Education, XXIII (Spring, 1975), pp. 67-77.

[2]R. D. Greer, "The Effect of Timbre on Brass-Wind Intonation," Experimental Research in the Psychology of Music, VI (1970), pp. 65-94.

[3]William Robert Swaffield, "Effect of Melodic Parameters on Ability to Make Fine-tuning Responses in Context," Journal of Research in Music Education, XXII (Winter, 1974), pp. 305-312.

[4]Joe Beck Buttram, "The Influence of Selected Factors on Interval Identification" (unpublished doctoral dissertation, University of Kansas, 1967), pp. 136-142.

scores showed little or no improvement when the musical intervals were sounded by their primary performance medium.

Research studies[1,2] plus the general hypothesis indicating that aural perception is related to the familiarity of the sound source were not supported by the present study. The four instrumental groups did not score significantly higher on the particular subtest that was sounded by the instrument the subjects regard as the primary performance medium.

4. Interval identification skills were facilitated when selected timbres sounded the musical intervals. An examination of the data disclosed that the Clarinet subtest yielded the highest interval identification scores when all instrumental groups were considered.

Though based on a visual observation of rank orderings, the results appear consistent with research indicating that aural acuity is more proficient under certain timbral conditions.[3]

Implications

The results of the study support an assumption that timbral manipulation and experience gained through the

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[1]Lola Cuddy, "Practice Effects in Pitch Perception" (unpublished doctoral dissertation, University of Toronto, 1965), pp. 75-91.

[2]Desmond Sergeant, "Measurement of Pitch Discrimination," Journal of Research in Music Education, XXI (Spring, 1973), p. 3.

[3]Greer, pp. 65-94.

primary performance medium are variables in the perception and identification of vertically-sounded sonorities. Although the conclusions suggested by the findings are primarily related to the experimental conditions of the study, certain implications for learning are offered.

The inclusion of the piano as a secondary performance area in the collegiate music curriculum is supported by the data. Participants in the present study claiming piano as the primary performance medium were found to be more proficient at the skill of interval identification than their counterparts in the other groups. If an objective of basic musicianship is the development of aural acuity, piano study would appear to contribute to the perception and identification of vertical sonorities as a component of the broader acuity objective.

The piano, as a timbral source, appears to be a valuable non-discriminatory tool for use in the development of selected aural skills relating to the perception and identification of vertical sonorities. However, other tone colors were found to be equally effective. In contrast, the study disclosed that certain timbral combinations did not facilitate the interval perception and identification process. The subtest utilizing a mixed timbre resulted in the lowest interval identification scores. On this basis, it is suggested that timbre is a contextual variable when considering aural perception skills.

Concerning the usefulness of the pure tone as a sound source, the study yields inconclusive evidence. Information suggests that the pure tone timbre utilized as one of the timbral variables was non-discriminatory. However, an observation that the Pure Tone subtest was a consistently low scoring timbral medium warrants further investigation.

The study disclosed that participants showed little, if any, improvement in interval identification skills when the intervals were sounded by instruments they regard as their primary performance medium. Based on these results, it is concluded that the sounding of vertical sonorities by one timbral source will not unfairly discriminate against instrumentalists who regard another sound source as their primary performance medium.

While the study found that Clarinetists were less proficient at interval identification skills than other instrumental classifications, the clarinet timbre was found to be the sound source yielding the highest identification scores among the various instrumental classifications when a weighting scale was used. Though unexplained, this observation is an additional implication that interval identification skills are not enhanced when the intervals are sounded by subjects' primary performance medium.

Recommendations for Additional Research

As the present study progressed through its various stages, the writer observed that many similar studies could be conducted which would yield additional information and expand the amount of knowledge now available concerning the effect of timbral change on musical interval perception. Pertinent recommendations for further research are listed as follows:

1. A study could be conducted using subjects whose primary performance medium was not among those used to sound intervals in the present experiment. Results of such a study could yield information concerning the effects of timbral change on the interval identification skills of vocalists, string performers, and wind instrumentalists not included in the present study.

2. Additional studies could be conducted employing different timbral sources. Of particular importance would be additional studies in the area of timbral effects on musicians' interval identification skills resulting from mixed timbres. Also, an experiment could be conducted utilizing wind instruments and vocal timbres to sound the musical intervals.

3. Research could be conducted concerning the effect of timbre on other aural discrimination skills. The areas of melodic interval perception and pitch recognition would be fruitful areas for additional study.

4. Further research utilizing a different response mode with compound intervals would yield additional information. Information gained from using a response mode in which the participants view printed musical items and are asked to respond to both visual and aural stimuli would be appropriate.

5. Additional information could be gained from a study of the generalization of interval identification skills from one timbral source to another. This would be helpful in determining the efficiency with which individuals respond to aurally presented materials as a function of timbral change.

BIBLIOGRAPHY

A. Books

1. Books by Author(s)

Anastasi, Anne. Psychological Testing. 3rd ed. New York: Macmillan Publishing Co., 1968.

Backus, John. The Acoustical Foundations of Music. New York: W. W. Norton and Co., 1969.

Barbour, J. Murray. Tuning and Temperament. East Lansing, Michigan: Michigan State College Press, 1953.

Bartholomew, Wilmer T. Acoustics of Music. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1952.

Bruning, James L., and B. L. Kintz. Computational Handbook of Statistics. Illinois: Scott, Foresman, and Co., 1968.

Campbell, Donald T., and Julian C. Stanley. Experimental and Quasi-Experimental Designs for Research. New York: Rand McNally Co., 1963.

Ess, Donald Van. The Heritage of Musical Style. New York: Holt, Rinehart and Winston, Inc., 1970.

Farnsworth, Paul R. The Social Psychology of Music. New York: The Dryden Press, 1958.

Goldman, Richard Franko. Harmony in Western Music. New York: W. W. Norton and Co., 1965.

Gordon, Edwin. The Psychology of Music Teaching. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1971.

Grout, Donald Jay. A History of Western Music. New York: W. W. Norton and Co., 1960.

Hays, William L. Statistics. New York: Holt, Rinehart, and Winston, 1963.

Helmholtz, H. L. F. On the Sensations of Tone. Trans. by Alexander J. Ellis. 6th ed. New York: Peter Smith, 1948.

Hindemith, Paul. The Craft of Musical Composition. Trans. by Arthur Mendel. New York: Associated Music Publishers Inc., 1942, Book I.

Hood, Mantle. The Ethnomusicologist. New York: McGraw-Hill Book Co., 1971.

Kerlinger, Fred N. Foundations of Behavioral Research. New York: Holt, Rinehart, and Winston, 1964.

Kwalwasser, Jacob, and Peter Dykema. Kwalwasser-Dykema Music Tests. New York: Carl Fisher, 1930.

Lehman, Paul R. Tests and Measurements in Music. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1968.

Lundin, Robert W. An Objective Psychology of Music. New York: The Ronald Press Company, 1953.

Mursell, James L. The Psychology of Music. New York: W. W. Norton and Company, 1937.

Nettl, Bruno. Music in Primitive Culture. Cambridge: Harvard University Press, 1956.

Noll, Victor. Introduction to Educational Measurement. 2nd ed. Boston: Houghton Mifflin Co., 1967.

Olson, Harry F. Music, Physics and Engineering. 2nd ed. New York: Dover Publications, Inc., 1967.

Révész, G. Introduction to the Psychology of Music. Trans. by G. I. deCourcy. Norman, Oklahoma: University of Oklahoma, 1954.

Seashore, Carl E. Psychology of Music. New York: McGraw-Hill Book Company, Inc., 1937.

Spohn, Charles L., and B. William Poland. Sounds of Music: Harmonic Intervals. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967.

Taylor, C. A. The Physics of Music Sounds. New York: The American Elseview Publishing Co., Inc., 1965.

Thomson, William E., and Richard P. Delone. Introduction to Ear Training. California: Wadsworth Publishing Co. Inc., 1968.

Whybrew, William E. Measurement and Evaluation in Music. Dubuque, Iowa: William C. Brown Co., 1962.

B. Periodicals

Aliferis, James, and J. E. Stecklein. "The Development of a College Entrance Test in Music Achievement." Journal of Research in Music Education, I (Fall, 1953), 83-96.

Bartlett, Dale L. "Effect of Repeated Listenings on Structural Discrimination and Affecting Response," Journal of Research in Music Education, XXI (Winter, 1973), 302-317.

Bullock, William J. "A Review of Measures of Musico-Aesthetic Attitude," Journal Of Research in Music Education, XXI (Winter, 1973), 139-150.

Cady, Henry C. "Tests and Measures in Higher Education: School Music Teachers," Journal of Research in Music Education, XV (Summer, 1967), 139-150.

Edmunds, E. M., and M. E. Smith. "The Phenomenological Description of Musical Intervals," American Journal of Psychology, XXXIV (1923), 287-291.

Greer, R. D. "The Effect of Timbre on Brass-Wind Intonation," Experimental Research in the Psychology of Music, VI (1970), 65-94.

Haack, Paul A. "The Influence of Loudness on the Discrimination of Musical Sound Factors," Journal of Research in Music Education, XXIII (Spring, 1975), 67-77.

Harriss, Ernest. "Study of a Behaviorally Oriented Training Program for Aural Skill," Journal of Research in Music Education, XXII (Fall, 1974), 215-225.

Henning, G. B., and S. L. Grosberg. "Effects of Harmonic Components on Frequency Discrimination," Journal of the Acoustical Society of America, XVIV, 5 (1968), 1386-1389.

Jeffries, Thomas B. "The Effects of Order of Presentation and Knowledge of Results on the Aural Recognition of Melodic Intervals," Journal of Research in Music Education, XV (Fall, 1967), 179-190.

Kersey, Robert E. "Effects of an Exploratory Program in Instrumental Music on the Aural Perception of Instrumental Timbre," Journal of Research in Music Education, XXI (Winter, 1973), 303-306.

Lundin, R. W. "The Development and Validation of a Set of Musical Ability Tests," Psychological Monographs, LXIII, 305 (1949), 1-20.

Madison, T. H. "Interval Discrimination as a Measure of Musical Aptitude," Archieves of Psychology, (1942), 1-99.

Pikler, Andrew. "History of Experiments on the Musical Interval Sense," Journal of Music Theory, X, 1 (1966), 55-94.

Saldanha, E. L., and J. F. Corso. "Cues and Identification of Musical Instruments," Journal of the Acoustical Society of America, XXXVI (1964), 20-21.

Sergeant, Desmond. "Measurement of Pitch Discrimination," Journal of Research in Music Education, XXI (Spring, 1973), 3-19.

Stecklein, John, and James Aliferis. "The Relationship of Instrument to Music Achievement Test Scores," Journal of Research in Music Education, V (Spring, 1957), 3-15.

Swaffield, William Robert. "Effect of Melodic Parameters on Ability to Make Fine-tuning Responses in Context," Journal of Research in Music Education, XXII (Winter, 1974), 305-312.

Zeitlin, L. R. "Frequency Discrimination of Pure and Complex Tones," Journal of the Acoustical Society of America, XXXVI (1964), 1207.

C. Unpublished Materials

Buttram, Joe Beck. "The Influence of Selected Facotrs on Interval Identification." Unpublished doctoral dissertation, University of Kansas, 1967.

Cuddy, Lola Lane. "Practice Effects in Pitch Perception." Unpublished doctoral dissertation, University of Toronto, 1965.

Greer, Robert Douglas. "The Effect of Timbre on Brass-Wind Intonation." Unpublished doctoral dissertation, University of Michigan, 1969.

Hurwitz, Robert Irving. "An Investigation Into the Perception of Root in Harmonic Intervals." Unpublished doctoral dissertation, Indiana University, 1970.

Leonard, Nels Jr. "The Effect of Certain Intrinsic and Contextual Characteristics of the Tone Stimulus on Pitch Discrimination." Unpublished doctoral dissertation, West Virginia University, 1967.

APPENDIX A

LETTER SENT TO BAND DIRECTORS AT COLLEGES AND UNIVERSITIES IN OKLAHOMA

APPENDIX A

Oklahoma
Baptist
University

SHAWNEE, OKLAHOMA 74801

Dear Mr.

I am currently engaged in a research project at the University of Oklahoma to study the effects of timbre on selected aural perception skills of instrumentalists. More specifically, I am studying the effect of timbre on the perception of harmonic intervals. For example, I am studying the effects of changing sound sources on students' ability to hear and correctly identify musical intervals.

In order to complete the experiment, I am soliciting the help and cooperation of other Band Directors such as yourself. For the research to be completed, it will be necessary for me to administer a short test of interval identification to groups of undergraduate music students. The entire test can be completed in less than 20 minutes. I would like to ask your help in the experiment by allowing me to administer the test to the university band students enrolled at your institution. Neither individual scores nor participating schools will be compared, since the experiment is in no way an attempt to compare institutions.

Please complete and return the enclosed card if you are willing to allow your students to be tested, and you will be contacted to arrange a convenient testing date for the students.

Please indicate on the enclosed card, if you would like to have a copy of the results of the study.

Respectfully Submitted,

Ron Howell

Mr. Ron Howell, Band Director
Oklahoma Baptist University
Shawnee, Oklahoma 74801

Encl: (1)

APPENDIX B

BIOGRAPHICAL INFORMATION QUESTIONNAIRE

APPENDIX B

BIOGRAPHICAL INFORMATION QUESTIONNAIRE

Biographical Information

(1) Name: ____________________

(2) Sex: ◯ Male ◯ Female

(3) Age: __________

(4) Grade Level/Classification: ◯ Fr. ◯ So. ◯ Jr. ◯ Sr.

(5) Degree Sought: ____________________

(6) With which band instrument are you the most experienced? __________

(7) Number of years you have studied or played the instrument listed; __________

(8) Major instrument (If not listed above): ____________________

(9) Number of years you have studied or played the instrument listed; __________

(10) Current semester of Theory and/or Ear Training Sequence in which you are Enrolled:

◯ Have Not Studied Theory

◯ First

◯ Second

◯ Third

◯ Fourth

◯ Completed Two-Year Theory Sequence

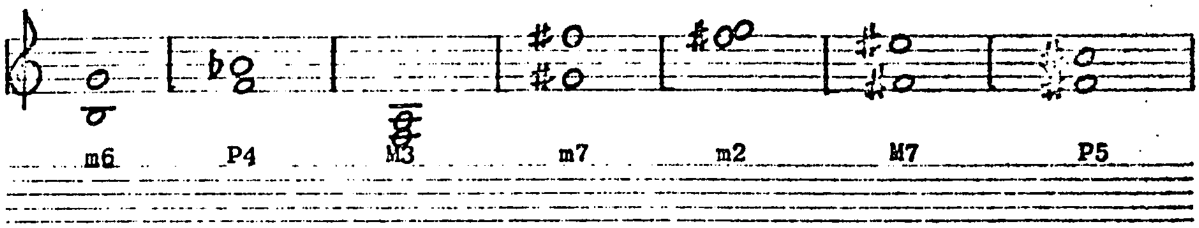
APPENDIX C

ORDER OF PRESENTATION OF MUSICAL INTERVALS ON THE FIVE TIMBRAL SUBTESTS

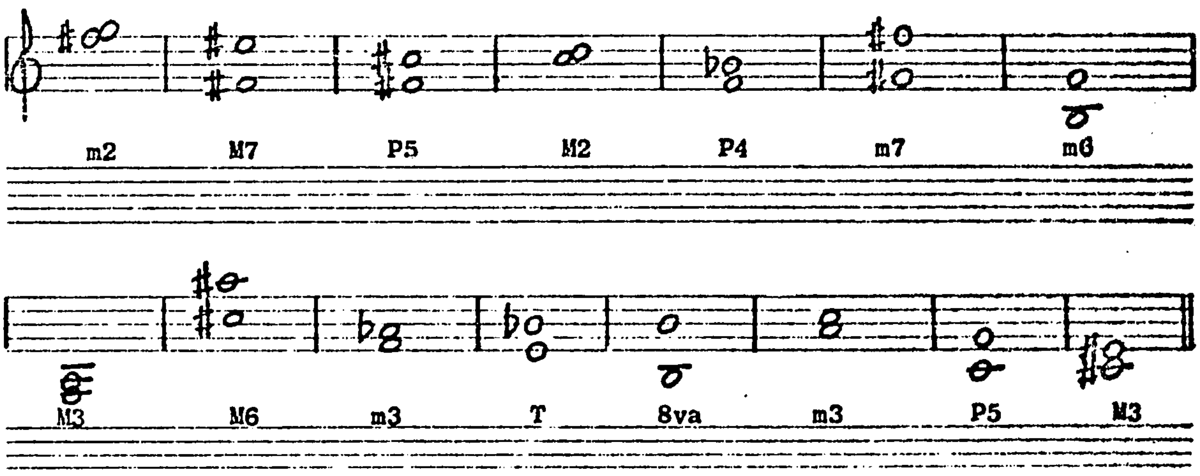
APPENDIX C

ORDER OF PRESENTATION OF MUSICAL INTERVALS ON THE FIVE TIMBRAL SUBTESTS

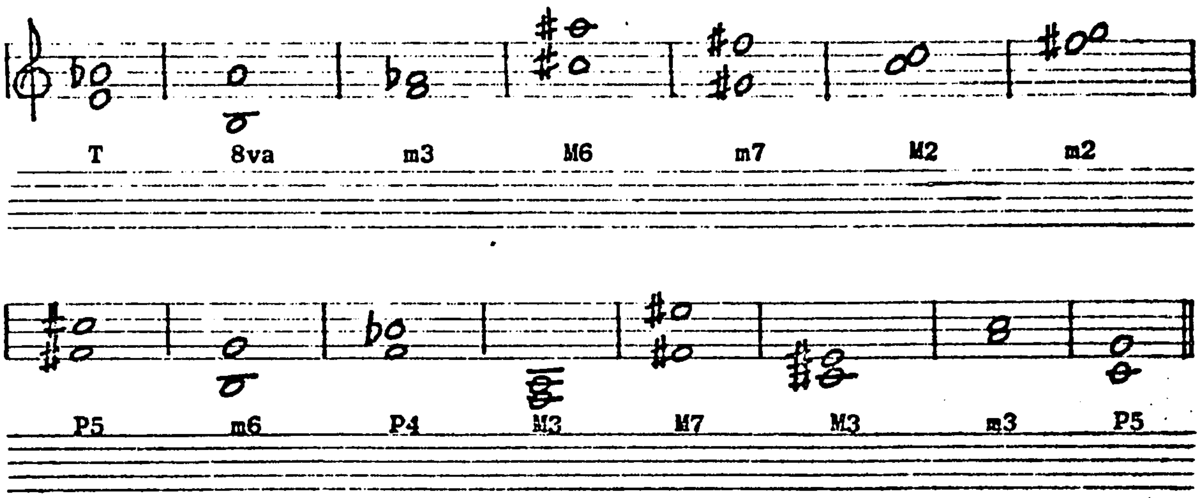
SUBTEST 1: PIANO



SUBTEST 2: PURE TONE

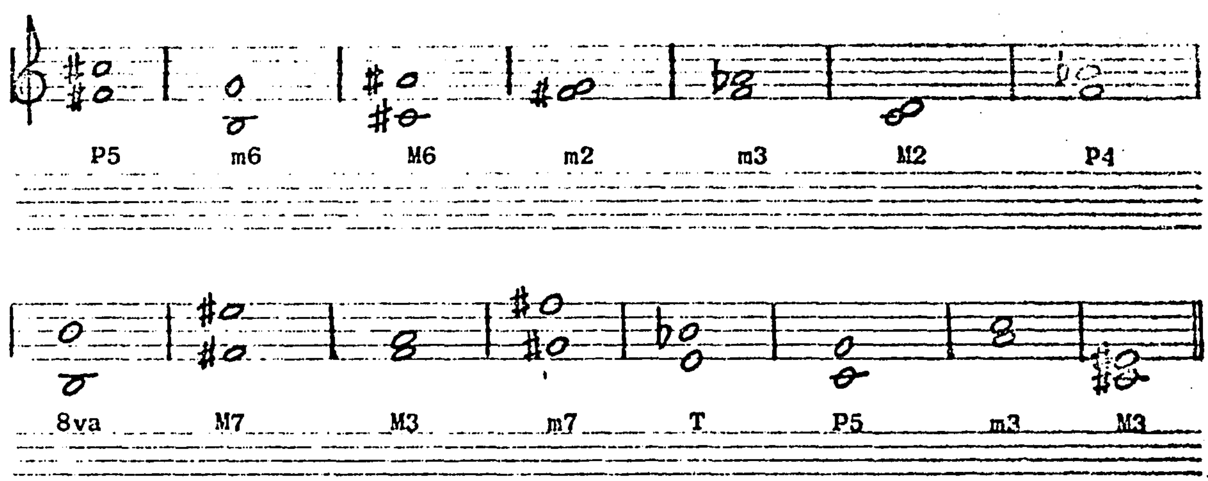


SUBTEST 3: CLARINET

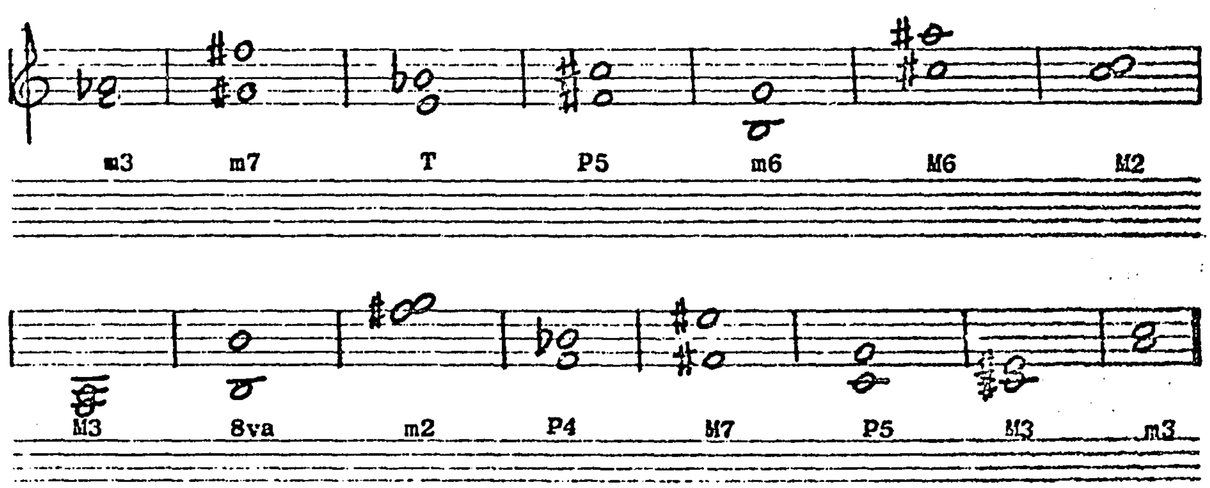


APPENDIX C (Cont'd.)

SUBTEST 4: FLUTE AND HORN



SUBTEST 5: TRUMPET



APPENDIX D

TEST OF INTERVAL IDENTIFICATION

APPENDIX D

TEST OF INTERVAL IDENTIFICATION

Subtest #1: **PIANO**

APPENDIX D (Cont'd.)

TEST OF INTERVAL IDENTIFICATION (Cont'd.)

Subtest #2: PURE TONE

APPENDIX D (Cont'd.)

TEST OF INTERVAL IDENTIFICATION (Cont'd.)

Subtest #3: CLARINET

APPENDIX D (Cont'd.)

TEST OF INTERVAL IDENTIFICATION (Cont'd.)

Subtest #4: FLUTE AND HORN

APPENDIX D (Cont'd.)

TEST OF INTERVAL IDENTIFICATION (Cont'd.)

Subtest #5: TRUMPET

APPENDIX E

TAPE-RECORDED DIRECTIONS FOR THE TEST OF INTERVAL IDENTIFICATION

APPENDIX E

TAPE-RECORDED DIRECTIONS FOR THE TEST OF INTERVAL IDENTIFICATION

The following directions were pre-recorded and presented in conjunction with oral directions to the participants:

> "The test you are about to take is an experiment involving interval identification skills. It is relatively short and will involve only a few minutes of your time. First, I play a musical interval. Next, you will be asked to identify each of the intervals and write the symbol identifying the intervals in the spaces provided. If you are not sure of the answer--guess. There is no penality for guessing. Before the actual test begins, five practice intervals will be presented. Mark your answers for these first five intervals in the section marked "Practice Intervals."

The five practice intervals were presented at this time. After the students had been allowed sufficient time to respond to the intervals, the tape continued with the following passage:

> "The answers to the five practice intervals are a major second, major third, perfect fifth, major sixth, and a perfect fourth."

The students were allowed to ask questions about the administration of the test before the next part of the directions was played. When all questions had been answered, the following passage was played:

> "We are now ready to being the Test of Interval Identification. Please note that there are five subtests with fifteen intervals on each subtest. There will be a short pause after each subtest is completed. Also note that the musical intervals on each subtest are sounded by different instruments. Do not let the changes in instrumental sounds cause you to hesitate in your answers."
>
> "Ready? . . . begin."

The seventy-five (n=75) musical intervals contained on the five timbral subtests were presented at this time.

APPENDIX F

RESPONSE FORM FOR THE TEST OF INTERVAL IDENTIFICATION

APPENDIX F

ANSWER BLANK FOR TEST OF INTERVAL IDENTIFICATION

Name:____________________ University:____________________

Directions: Place the symbols you ordinarily use to identify the following intervals in the spaces provided (Example, octave 8va or P8). Distinctions between "major" and "minor" should be clear. Write the complete word or abbreviate "maj." or "min." Use symbols whenever possible elsewhere.

(1) Minor Second________

(2) Major Second________

(3) Minor Third________

(4) Major Third ________

(5) Perfect Fourth________

(6) Augmented Fourth, Diminished Fifth, or Tritone ________

(7) Perfect Fifth________

(8) Minor Sixth________

(9) Major Sixth________

(10) Minor Seventh________

(11) Major Seventh________

(12) Octave ________

Practice Intervals:

1. ______ 2.______ 3.______ 4.______ 5.______

SUBTEST #1

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____

9.____ 10.____ 11.____ 12.____ 13.____ 14.____ 15.____

SUBTEST #2

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____

9.____ 10.____ 11.____ 12.____ 13.____ 14.____ 15.____

SUBTEST #3

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____

9.____ 10.____ 11.____ 12.____ 13.____ 14.____ 15.____

SUBTEST #4

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____

9.____ 10.____ 11.____ 12.____ 13.____ 14.____ 15.____

SUBTEST #5

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____

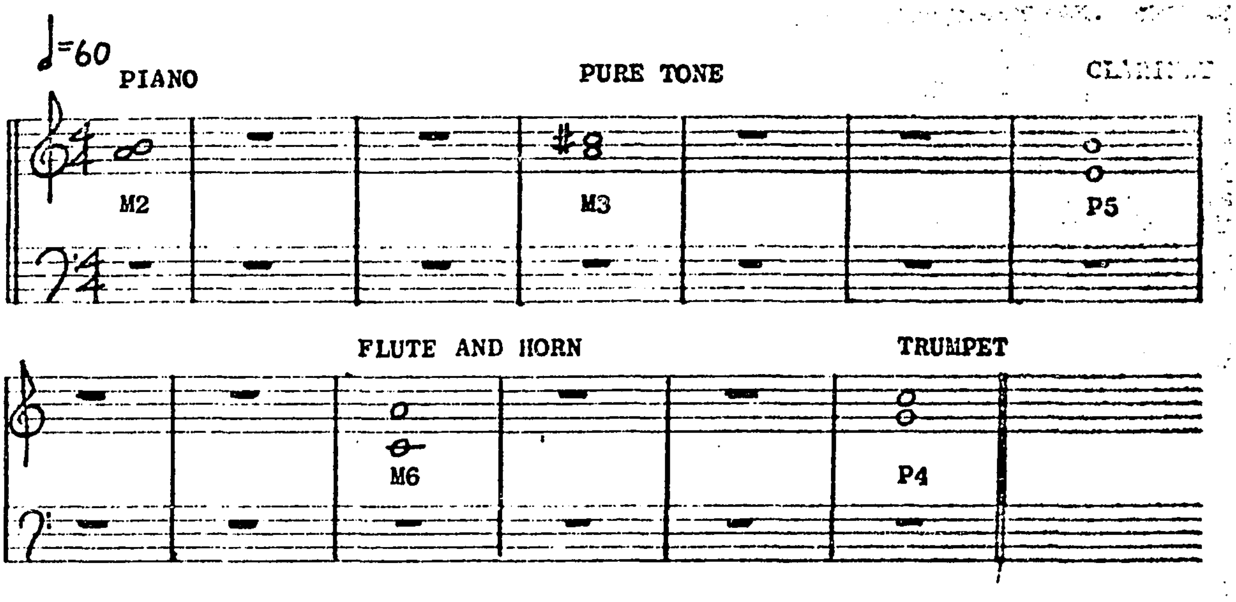
9.____ 10.____ 11.____ 12.____ 13.____ 14.____ 15.____

APPENDIX G

PRACTICE INTERVALS CONTAINED ON THE TEST OF INTERVAL IDENTIFICATION

APPENDIX G

PRACTICE INTERVALS CONTAINED ON THE TEST OF INTERVAL IDENTIFICATION



APPENDIX H

THE FOUR INSTRUMENTAL GROUPS' RAW SCORES FROM THE FIVE SUBTESTS OF THE INTERVAL IDENTIFICATION MEASURE

APPENDIX H

Table 14. The Pianists' Raw Scores (Correct Responses) To the Five Subtests of the Interval Identification Measure.

Subject Number	Piano Subtest	Pure Tone Subtest	Clarinet Subtest	Flute and Horn Subtest	Trumpet Subtest	Total Score
	Number of Correct Responses by Subtest					
1	12	11	12	10	10	55
2	15	15	14	15	14	73
3	12	14	15	15	14	70
4	15	15	15	15	15	75
5	8	5	7	6	8	34
6	15	15	15	13	14	72
7	4	6	5	6	7	28
8	15	15	15	15	14	74
9	14	15	15	15	15	74
10	15	15	15	15	15	75
11	12	13	14	12	10	61
12	7	5	11	12	9	44
13	7	10	9	6	12	44
14	15	15	15	14	15	74
15	8	8	6	6	5	33
16	10	9	6	8	7	40
17	10	6	6	3	7	32
18	10	10	10	8	7	45
19	15	15	14	14	15	73
20	13	12	10	11	14	60
Mean . . .	11.60	11.45	11.45	10.95	11.35	56.80
Standard Deviation .	3.338	3.708	3.667	3.892	3.454	17.02

APPENDIX H (CONT'D.)

Table 15. The Clarinetists' Raw Scores (Correct Responses) To the Five Subtests of Interval Identification Measure

	Number of Correct Responses by Subtest					
Subject Number	Piano Subtest	Pure Tone Subtest	Clarinet Subtest	Flute and Horn Subtest	Trumpet Subtest	Total Score
1	6	7	7	8	8	36
2	5	7	8	4	6	30
3	2	3	5	3	5	18
4	7	8	9	4	10	38
5	2	4	4	4	3	17
6	11	6	5	7	7	36
7	5	4	4	5	8	26
8	11	11	12	12	13	59
9	15	15	15	15	15	75
10	7	6	4	5	3	25
11	4	7	5	6	7	29
12	3	2	2	3	4	14
13	1	3	1	3	4	12
14	8	5	4	9	8	34
15	9	6	6	5	6	32
16	6	6	3	4	7	26
17	14	13	12	13	14	66
18	5	6	9	4	5	29
19	9	10	14	10	14	57
20	5	6	8	2	7	28
Mean . . .	6.75	6.75	6.85	6.30	7.70	34.35
Standard Deviation .	3.753	3.238	4.707	3.607	3.607	16.77

APPENDIX H (CONT'D.)

Table 16. The Trumpeters' Raw Scores (Correct Responses) To the Five Subtests of the Interval Identification Measure

	Number of Correct Responses by Subtest					
Subject Number	Piano Subtest	Pure Tone Subtest	Clarinet Subtest	Flute and Horn Subtest	Trumpet Subtest	Total Score
1	8	8	10	7	9	42
2	11	9	10	10	9	49
3	7	10	11	7	9	44
4	13	12	11	13	11	60
5	8	10	9	6	7	40
6	7	8	9	6	12	42
7	5	1	3	3	3	15
8	8	6	4	2	5	25
9	12	13	13	13	13	64
10	14	12	14	14	13	67
11	12	12	12	10	10	56
12	9	8	10	12	10	49
13	4	3	8	5	9	29
14	13	11	12	14	15	65
15	12	13	13	14	15	67
16	10	8	10	10	12	50
17	1	2	3	3	5	14
18	4	4	6	4	4	22
19	11	11	10	7	9	48
20	5	6	6	4	3	24
Mean . . .	8.70	8.35	9.20	8.20	9.20	43.60
Standard Deviation .	3.523	3.582	3.187	4.020	3.480	16.78

APPENDIX H (CONT'D.)

Table 17. The Other Instrumentalists' Raw Scores (Correct Responses) To the Five Subtests of the Interval Identification Measure

Subject Number	Piano Subtest	Pure Tone Subtest	Clarinet Subtest	Flute and Horn Subtest	Trumpet Subtest	Total Score
	Number of Correct Responses by Subtest					
1	10	13	11	7	10	51
2	15	15	15	14	15	74
3	7	8	9	13	8	45
4	7	5	6	4	6	28
5	7	5	11	10	4	37
6	13	8	10	6	10	47
7	11	9	12	13	9	54
8	3	8	7	5	5	28
9	9	11	12	9	9	50
10	7	8	7	4	9	34
11	13	12	10	13	10	58
12	8	3	7	5	6	29
13	8	12	7	8	9	44
14	11	12	10	10	10	53
15	15	15	14	15	15	74
16	5	3	5	1	5	19
17	10	9	8	9	10	46
18	8	7	6	4	5	30
19	7	4	5	6	5	27
20	4	5	5	4	4	22
Mean. .	8.90	8.60	8.85	8.00	8.20	42.55
Standard Deviation. . .	2.577	3.200	2.937	4.060	3.140	15.21

APPENDIX I

CONSULTANTS WHO ASSISTED IN ESTABLISHING THE VALIDITY OF THE TEST OF INTERVAL IDENTIFICATION

APPENDIX I

Name	Title and/or Position
Dr. C. L. Bass	Professor of Music, Oklahoma Baptist University
Dr. William Horton	Professor of Music, Oklahoma Baptist University
Mr. Dan Hodges	Assistant Professor of Music, Oklahoma Baptist University
Mr. Ron Lewis	Assistant Professor of Music, Oklahoma Baptist University
Mr. Jack Pearson	Assistant Professor of Music, Oklahoma Baptist University
Dr. Ralph Verrastro	Professor of Music, University of Oklahoma
Dr. Edward Porter	Test Construction Specialist and Research Statistician

Figure 4. Consultants Who Assisted in Establishing the Validity of the Test of Interval Identification.

APPENDIX J

PARTICIPATING INSTITUTIONS AND THE DATES OF TEST ADMINISTRATION

APPENDIX J

Participating Institution	Testing Date
Central State University	December 3, 1975
Oklahoma Baptist University	January 15-16, 1976
Oklahoma City University	January 20, 1976
Oklahoma State University	December 3, 1975
Phillips University	December 9, 1975
Southwestern Oklahoma State University	December 8, 1975
Tulsa University	December 10, 1975
University of Oklahoma	January 27, 1976

Figure 5. Participating Institutions and the Dates of Test Administration.