Order Number 9208693

An application of chunking to the memory and performance of melodic patterns

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The University of Michigan, 1991

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AN APPLICATION OF CHUNKING TO THE MEMORY AND PERFORMANCE OF MELODIC PATTERNS

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Music Education)
in The University of Michigan
1991

Doctoral Committee:

Professor James O. Froseth, Chair
Professor James Dapogny
Associate Professor Catherine Nadon-Gabrion
Professor M. Anthony Schork

...What about the magical number seven? What about the seven wonders of the world, the seven seas, the seven deadly sins, the seven daughters of Atlas in the Pleiades, the seven ages of man, the seven levels of hell, the seven primary colors, the seven notes of the musical scale, and the seven days of the week? What about the seven-point rating scale, the seven categories for absolute judgment, the seven objects in the span of attention, and the seven digits in the span of immediate memory? ...Perhaps there is something deep and profound behind all these sevens, something just calling out for us to discover it.

George A. Miller, 1956

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For Mindy

ACKNOWLEDGMENTS

Initial thanks go to committee chair James O. Froseth for providing the impetus to explore the world of chunking, and for his guidance in the shaping and completion of this study. The researcher also gratefully acknowledges Catherine Nadon-Gabrion and James Dapogny for serving on the thesis committee and offering their support, encouragement, and counsel. Gratitude is extended especially to committee member M. Anthony Schork for his direction in the statistical analysis of the experiment, and to Maher Shawer, Mark Nutter, and the IUP computer services for providing the facilities and systems support for statistical analysis.

Furthermore, generous thanks are extended to the Department of Music and the College of Fine Arts at Indiana University of Pennsylvania, as well as to the State System of Higher Education in Pennsylvania, for providing the location and the means to launch this project. The researcher especially wishes to thank the freshmen music students who participated in the study, as well as theory skills teachers, Carol Teti, Edwin Fry, John Scandrett, and composition/theory chair Daniel Perlongo. Finally, the researcher is grateful to many supportive colleagues, especially to John Hadju Heyer, dean of the College of Fine Arts at IUP, John Kuehn, Sarah Mantel, Joanne Rutkowski, and Sunny Roller for their encouragement and assistance in the completion of this dissertation.

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CHAPTER I

RESEARCH PROPOSAL

Introduction

> Music education is part of the broader aesthetic education which deals with all essential aesthetic responsiveness of human beings. It is a nonverbal art which can provide a visual or aural model that can be helpful to a learner.
>
> Malcolm Tait[1]

Learning is an active process dependent upon the storage and retrieval powers of the working memory, which is highly individual, and is affected by the total environment surrounding the learner. In music, learning results from a variety of prior, rewarding musical experiences impressed in the memory, and it is to this end that the music educator is dedicated. Research and writing in music learning theory has always emphasized the importance of experiencing music as the essential part of the learning process. Before music reading, or theoretical study, students should already have experienced listening, singing, playing, and moving to music. Peters, in *Music Teaching and Learning*, states this simply, "You do what you do, not something else."[2] Reimer warns that "isolating the study of music from musical experience insures a sterility which can only weaken *aesthetic sensitivity*," his description of musical perception.[3]

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[1]Malcolm Tait and Paul Haack, *Principles and Processes of Music Education* (New York: Teachers College Press, Columbia University, 1984), p. 7.

[2]G. David Peters and Robert F. Miller, *Music Teaching and Learning* (New York: Longman Inc., 1982), p. 114.

[3]Bennett Reimer, *A Philosophy of Music Education* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1970), p. 138.

However, musical perception is also concerned with knowing what to hear and how to remember it. Ausubel asserts that perceptions grow and become organized into structures only when they are catalogued and labeled into the memory.[4] It is doubtful, though, that this is a verbal process, but depends, rather, upon impressions received and recalled by the senses of sight, sound, and the kinesthetic. In any case, it is apparent that an investigation into the singular dimensions of the musical memory is crucial to the teaching and learning of music. In 1978, the Music Educators National Conference sponsored the first session of the Ann Arbor Symposium.[5] The purpose of this conference was to involve psychologists and music educators in the application of learning theory to the teaching and learning of music. Auditory perception and memory were two highlighted topics, but reports revealed that psychologists had little information about memory for specific musical concepts, especially pitch. It will be shown in a review of the literature that, since then, music research has focused on the illumination of various methods to improve auditory perception. Moreover, contemporary music education methodologists such as Froseth,[6] Gordon,[7] Orff,[8] Kodály,[9] and Suzuki,[10] emphasize the development of aural skills through hands-on musical experience. However, few studies have specifically targeted the application of memory research to the teaching and learning of

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[4]Peters, p. 115

[5]Malcolm Tait, "Self in Sound: Properties and Qualities of the Musical Experience," *Music Educators Journal* 67 (November 1980) : 50-51.

[6]James O. Froseth, *The Comprehensive Music Learning Sequence: Teacher Planning Guide* (Chicago: G.I.A. Publications, Inc., 1984), p. 1.

[7]Darrel L. Walters and Cynthia Crump, *Readings in Music Learning Theory* (Chicago, IL: G.I.A. Publications, Inc., 1989).

[8]Susan Wheatley and Sarah Mantel, "Children's Opera: A Creative Approach," *Pennsylvania Music Educators Association* (November 1990), p. 9.

[9] Lois Choksy, *The Kodály Method* (Englewood Cliffs, NJ: Prentice Hall, Inc., 1974), p. 4.

[10]Shinichi Suzuki, *Nurtured by Love*, trans. Waltroud Suzuki. (New York: Exposition Press, 1969).

aural music skills. This dissertation investigates the effect of one theory of memory processing called *chunking* on the musical memory, with the hope that this exploration will offer some insight about how we remember and recall musical data.

Justification

Chunking has been chosen as the focus of this study primarily because it has been identified as a possible means for increasing capacity in the short-term memory. Learning theorists, historically, have hypothesized that the number of items that can be held in the short-term memory is limited; we can retain about five to seven items. But the automatic memory process of chunking enables more information to be packed in each "chunk," thereby increasing memory capacity. This is possible because chunking calls upon familiar contextual structuring devices which have been stored in the long-term memory in order to link numerous items into one memory unit. Music educators may be able to capitalize on this process by identifying which structuring devices in music enable the memory to reduce several items of information into one memory chunk. For example, it is possible for a series of tones to be stored in the short-term memory as one item of information instead of many separate memory items corresponding to each successive tone, if its melodic contour, rhythmic pattern, and harmonic structure can be perceived as a unified musical gesture. Therefore, the first goal of this study is to investigate which structuring devices in music best promote and enable chunking in the memory and performance of music. It seems likely that musical contexts which combine melody, rhythm, and harmony provide the most efficacious experiences in the development of auditory skills. Therefore, this study hypothesizes that through chunking, the structuring devices of melody, rhythm, and harmony may account for differences in the memory and performance of melodic patterns.

Additionally, chunking has been targeted for investigation because its implementation depends upon previous musical experiences. The second project goal is to provide a profile showing the impact of a variety of experiences in one's previous musical background, since chunking depends upon familiarity with related memory structures stored in the long-term memory. Researchers precomprehensions about chunking are that it is an unconscious mechanism which calls upon information in long-term memory schemas. It works because of pre-existing conditions in the memory. In other words, one's ability to activate the short-term memory mechanism of chunking is, in part, determined by musical experiences stored in the long-term memory which enable structuring devices to "organize" melodic patterns. Therefore, a second hypothesis is that previous musical background might also have a significant impact on chunking ability which may account for differences in the memory and performance of melodic patterns.

These two research objectives bring to the forefront many questions for examination. How do musical ears remember? Does the memory utilize chunking to assist in discriminating between melodic patterns? If so, what kinds of musical training exercises would facilitate the use of chunking in the memory and performance of melodic patterns? What factors in one's musical background would significantly impact chunking ability? And, finally, does musical context impact the chunking mechanism in the memory and performance of melodic phrases?

Background

Chunking can provide clues about how musical ears remember. The history of short-term memory research can be traced to Ebbinghaus who, writing in the nineteenth century, claimed, through a series of experiments, that memory has a finite capacity of seven units. For over fifty years, this theory remained unchallenged.[11] Then in a 1956 article, entitled, "The Magical Number of Seven, Plus or Minus Two," George Miller

[11]Hermann Ebbinghaus, *Memory: A Contribution to Experimental Psychology,* trans. Henry A. Ruger and Clara E. Bussenius (New York: Dover Publications, 1964), p. 54.

presented his chunking theory, claiming that learners could reorder multiple items of information into a higher-order unit, thereby increasing memory capacity.[12] This idea which is based on a theory of the hierarchical structuring of information in the long-term memory, influenced the propensity for experimental research to focus on memory processes. A thorough investigation of these studies along with a theoretical background for chunking will be presented in the literature review which follows in chapter 2. The focus of chapter 2 will be to briefly summarize extant research and literature upon which assumptions about chunking can be drawn. The chapter also traces the musical application of chunking through a salient discussion of music education philosophy, music psychology, and music learning theory.

Previous literature and research models will be examined in order to answer four areas of questioning concerning the musical application of chunking. (1) How do musicians call upon information already stored in the long-term memory in order to remember and recall new musical data? (2) What are the organizational structures in music which enable the process of chunking? (3) Given that chunking is based on the assumption that learning is approached holistically, can it also be assumed that music is perceived as a Gestalt, that is, in a context which includes melodic, rhythmic and harmonic backgrounds? (4) What types of musical training procedures can best enable the memory system of chunking?

The research and application of music aptitude tests (Seashore, Kwalwasser-Dykema, Drake, Gordon[13]) may offer a more precise definition of what constitutes a "musical unit of memory" in order to determine the dimensions of musical capacity. Some music psychologists (Seashore, Mainwaring, Bentley) believe music is perceived in

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[12]George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* 63 (January 1956) : 81.

[13]Carl Seashore, *Psychology of Music* (New York: McGraw-Hill Book Company, 1938); and Edwin E. Gordon, *The Nature, Description, Measurement, and Evaluation of Music Aptitudes* (Chicago: G.I.A. Publications, 1986).

separate elements, but Wing, Révész, McLeish and Shuter believe it is perceived as a general ability.[14] Still others (Lundin, Rubenstein, Heinlein) have done research about memory and whole learning methods.[15] Chapter 2 will highlight the writings and research of music educators and learning theorists who support the hypothesis that learning is linked to a holistic process, such as Mursell,[16] Leonhard and House,[17] Reimer,[18] Peters, Tait[19], Froseth,[20] Jaques-Dalcroze,[21] and Orff,[22] among others. In terms of aural musicianship training, a significant number of studies indicate that melodic, rhythmic, and harmonic syntax can offer clues to expanding units of memory. Petzold's[23] study infers that harmonic context is a significant unifying structure which can reduce the storage effort of memory information, as do studies by Humphreys and Stauffer. Rhythmic contextual clues to memory and performance are also suggested in studies by Madsen and Staum,[24] Duke and Pierce,[25] and Zimmerman and Sechrest.[26] Inferences can also be

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[14]Shuter, Rosamond Shuter, *The Psychology of Musical Ability* (London: Methuen and Co. Ltd., 1968).

[15]Robert W. Lundin, *An Objective Psychology of Music* (New York: Ronald Press Company, 1953).

[16]James L. Mursell, *Education and Musical Growth.* (Boston: Ginn and Co., 1948).

[17]Charles Leonhard, and Robert House. *Foundations and Principles of Music Education* (New York: McGraw-Hill, 1959.)

[18] Bennett Reimer, *A Philosophy of Music Education* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1970).

[19]Tait and Haack, p. 7.

[20]James O. Froseth,*The Comprehensive Music Learning Sequence: Teacher Planning Guide* (Chicago: G.I.A. Publications, Inc., 1984), p. 5.

[21]Émile Jaques-Dalcroze, *Rhythm, Music, and Education,* trans. Harold F. Rubenstein. New York: Putnam's Sons, 1921.

[22]Susan E. Wheatley, "Creativity: Exploring the Possibilities," *The Orff Echo* 21 (Winter 1989) : 8.

[23]Robert G. Petzold, "The Development of Auditory Perception of Music Sound by Children in the First Six Grades," *Journal of Research in Music Education* 11 (Spring 1963) : 21-43.

[24]Clifford K. Madsen, and Myra J. Staum, "Discrimination and Interference in the Recall of Melodic Stimuli," *Journal of Research in Music Education* 31 (Spring 1983) : 15-31.

drawn from other research studies (Harrison, Rainbow, Boyle, Froseth, Dickey, Delzell, Sang, *et. al.* [27]) as to what types of musical training procedures can best enable the memory processing system of chunking.

As a result of this literature review, two research questions were formulated in order to address the goals set forth in this project. (1) In which musical context can the reductive information process of chunking be triggered in order to best increase the memory and performance of melodic patterns: A) a melodic, rhythmic, and harmonic context? B) a melodic and rhythmic context? or C) a melodic context only? (2) What types of music experiences in one's previous musical background have the most impact on chunking abilities in the memory and performance of melodic patterns?

Method and Analysis

An experiment will be designed and completed in order to investigate the research questions stated above. Upon surveying the existing research, it was deemed probable that the more holistic that the musical context is, the more beneficial the treatment would be. The research also suggests that a rich musicai background impels musical perception. Therefore, two hypotheses will be tested during the course of this experiment. First, it is hypothesized that the treatment group which practices patterns set in a holistic music context with melody, rhythm, and harmony will be most effective in increasing the memory and performance of melodic patterns as measured by a posttest of aural skills. A second hypothesis predicts that the previous musical background of each student, nested in a survey questionnaire, might also have a significant impact on chunking abilities, since

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[25]Robert A. Duke, and Michael A. Pierce, "Effects of Tempo and Context on Transfer of Performance Skills," *Journal of Research in Music Education* 39 (Summer 1991) : 93-100.

[26]Marilyn P. Zimmerman and Lee Sechrest, *How Children Conceptually Organize Musical Sounds* (Bethesda, MD: ERIC Reproduction Service, ED 028 200, 1969).

[27]see Chapter 2, pp. 30-34.

chunking depends upon familiarity with related memory structures stored in the long-term memory. The method of study will be divided into six phases: selection of the population sample; preparation of treatment tapes; selection of a diagnostic test for pre-and posttesting; distribution of a student survey questionnaire to analyze background data; administration of the treatment; and, statistical analysis of the results.

The sample will consist of college freshmen music students who are randomly divided into four groups as follows: (1) a treatment group which will practice melodic patterns accompanied by a rhythmic and harmonic background; (2) a treatment group which will practice melodic patterns accompanied by a rhythmic background; (3) a treatment group which will practice unaccompanied melodic patterns; and, (4) a control group which will receive no group practice sessions.

Three sets of training tapes will be prepared to practice the memory and performance of a variety of melodic patterns. While patterns will be the same for each treatment group, they will differ in the amount and type of contextual information given. In the most holistic treatment group, the melody will be augmented by a harmonic and rhythmic accompaniment. In the second treatment group, the melody will be accompanied by a rhythmic background. In the third treatment group, the melody will be heard without any background or accompaniment. Examples illustrating these tapes are presented and described in chapter 3.

Before initiation of the treatment, each student's level of aural musicianship skills will be measured by Froseth's *Test of Melodic Ear-to-Hand Coordination,* [28] a fifteen minute diagnostic exam which determines auditory skills through listening and performing a variety of melodic patterns. This test was used as a pretest measure in studies by Stauffer,[29] Humphreys,[30] Kuehn,[31] Dickey,[32] and Wilder,[33] and has been established as a criterion-referenced test with high reliability.

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[28]James O. Froseth, *Test of Melodic Ear-to-Hand Coordination* (Unpublished diagnostic test, 1982).

[29]Sandra L. Stauffer, "An Investigation of the Effects of Melodic and Harmonic Context on

The treatment will be administered for ten minutes, three times a week for a twelve week time period corresponding to the college semester. Students will practice the treatment tapes in an electronic piano lab, where they will listen to the patterns through ear phones, and then repeat the patterns on their own keyboard. Since the second hypothesis theorizes that previous musical background may impact chunking ability, subjects will also be asked to complete a questionnaire about their musical past. This questionnaire, entitled *Aural Skills Experiment Survey,* asks students to list their major instrument, years of private music study, and previous junior high and high school musical experience. During the last week of the semester, the *Test of Melodic Ear-to-Hand Coordination* will be readministered as a posttest measure of the memory and performance of melodic patterns.

After the treatment phase, the information will be compiled into a data set for analysis to determine differences between the group means. Chapter 4 presents a complete statistical analysis of both the background and intervention stage data. The student's musical past is interpreted by describing and analyzing pretest scores in order to determine the subject's beginning aural skills level. In addition, independent background variables extrapolated from each student's questionnaire which describes the student's musical past are defined and analyzed in terms of their relationship to pretest scores. The intervention data will be analyzed by a regression model which assesses the effect of each treatment

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the Development of Singing Ability in Primary Grade Children." Ph.D. dissertation, The University of Michigan, 1985.

[30]Jere T. Humphreys, "Measurement, Prediction, and Training of Harmonic Audiation and Performance Skills" *Journal of Research in Music Education* 34 (Fall 1986) : 192-99.

[31]John Kuehn, "The Correlation of Aural Skills and Grade Evaluation of Undergraduate Music Majors," *Pennsylvania Music Educators Journal* 8 (Spring 1989) : 25-26.

[32]Marc R. Dickey, "A Comparison of Verbal Instruction and Nonverbal Teacher-Student Modeling in Instrumental Ensembles," *Journal of Research in Music Education* 39 (Summer 1991) : 132-142.

[33]Michael Wilder, "An Investigation of the Relationship Between Melodic Ear-to-Hand Coordination and Written and Aural Theory Skills within an Undergraduate Music Theory Context" (Ph.D. dissertation, The University of Michigan, 1988).

after adjusting for the pretest scores, and any other background variables which show significant correlations to pre- and posttest scores.

Summary of Proposal

To summarize, this project will examine the musical application of chunking to the memory and performance of melodic patterns. There are two overriding goals for the study: (1) to investigate which structuring devices in music best promote and enable chunking in the memory and performance of music; and (2) to provide a profile showing the impact of a variety of experiences in one's previous musical background on the automatic memory mechanism of chunking. A review of literature will analyze how musicians remember and recall new musical data. A treatment period will be designed in order to test the hypothesis that training can facilitate the use of chunking in the memory and performance of melodic patterns. An examination of musical background will demonstrate how the memory utilizes chunking to assist in musical discrimination. And, an analysis of test results will make implications about the role of musical context on chunking ability. Through these analyses of experimental treatment and musical background, the researcher hopes that findings about chunking will offer a fresh approach for the active process of teaching and learning music.

CHAPTER II

LITERATURE REVIEW

A theoretical background for chunking in music learning theory can be found in a review of research studies pertaining to memory. Based on these theoretical constructs, an application of chunking in music follows with a review of relevant literature in music education philosophy, music psychology, and learning theory.

Theoretical Background

The theory of chunking attempts to explain increases in the short-term memory which, historically, has been theorized to have finite capacity. In 1885, Ebbinghaus found that the maximum number of items he could reproduce perfectly immediately following a single presentation was generally seven.[1] Researchers since that time have focused on the relationship of memory to skill ability and method of presentation, but have not attempted to increase memory span. It was not until 1956 that Miller challenged the concept of a limited memory capacity. He coined the term chunking which he defined as an encoding mechanism used to recode information. He discovered that when learners are presented with information sets for retention, one way they can reduce the amount to be remembered is to recode subsets of more than one item into a single higher-order unit. In order to recode the information, it must be reorganized into one memorial representation. Recoding

[1]Hermann Ebbinghaus, *Memory: A Contribution to Experimental Psychology,* trans. Henry A. Ruger and Clara E. Bussenius (New York: Dover Publications, 1964), p. 54.

increases the amount of information within the unit and therefore, increases the memory capacity without going beyond "the Magical Number Seven. . ."[2]

Since then, memory research has been focused on the underlying processes of encoding, storage, and retrieval, and the aspects of forming strategies to process information into long-term memory schemas. These memory strategies are rehearsal, grouping, chunking, and retrieval strategies such as association. Rehearsal refers to rote repetition of data in order to assimilate new information. Grouping divides information into categories, such as the list of musical terms as follows:

> <u>Musical Terms:</u> adagio, allegro, vivace, largo, fermata, legato, staccato, pizzicato, piano, mezzoforte, fortissimo, mezzopiano
>
> <u>Grouping the Musical Terms:</u>
> <u>Tempo markings</u>: adagio, allegro, vivace, largo
> <u>Articulations:</u> fermata, legato, staccato, pizzicato
> <u>Dynamics:</u> piano, mezzoforte, fortissimo, mezzopiano

There are twelve items in the musical terms list to remember. Grouping doesn't decrease this number of items – it just stores the items into three smaller data sets. Chunking, on the other hand, is subjective organization which changes the information into smaller subsets, i.e., three individual pitches can be changed into one item of memory if they are perceived as a chord. Retrieval strategies such as association work differently from rehearsal, grouping or chunking. In fact, association does not necessarily have any content relationship to the items of information.

The chunking memory strategy calls upon information already stored in the long-term memory. In other words, chunking depends on a knowledgeable perception of the stimuli, and, therefore, is positively related to recall. The chunking process is different from retrieval strategies such as association which assumes no direct connection between items, and therefore increases the amount of information which must be processed. It is also more expedient than rehearsal which relies on rote repetition as a processing

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[2]George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* 63 (January 1956) : 81.

mechanism. For example, perhaps a pianist, while memorizing, has overlooked a B-natural which occurs before a cadence point in F-major. In an attempt to unlearn an incorrect B^b (which changes the sound of the chord from G-major to G-minor) the pianist may apply a rehearsal technic. The cadence would be practiced several times in order to process the new memory schema which could be learned as a purely muscle (motor) response. The pianist could also apply the retrieval strategy of association, "I will remember that B-natural because the piece is written by Beethoven, whose name begins with a B." The novelty of the association is often what inspires memory; it may have little to do with the music. Finally, the pianist could integrate the B-natural within the context of the harmonic structure, "This cadence uses an applied dominant chord (V/V) which has a major sound, instead of a supertonic (II) chord which has a minor sound." In this case the corrected note is chunked with the rest of the chord tones so that only one unit of memory is processed, a G-major chord.

However, it bears repeating that chunking is an automatic processing system and it is doubtful that the pianist would need to verbalize the process as supposed above. It is automatic because chunking depends on previous knowledge and is thus a knowledge-specific strategy dependent on the information already processed into long-term memory. Only the pianist who is aurally familiar with the cadential sequence of the secondary dominant to the dominant to the tonic (V/V - V^7 - I) can apply chunking in this situation. Following this line of reasoning, it can then be assumed that a pianist with high auditory discrimination skills would chunk automatically, and therefore, would correct the harmonic sequence more quickly and remember it more reliably. It may be thus hypothesized that aural music skills are essential to identifying the organizational structures in music which would enable the process of chunking.

The role that the long-term memory plays in chunking can also be demonstrated by the following cognitive example which concerns the reading and retention of sense and nonsense verbal material. Consider the task of memorizing the following sets of letters:

aattnngtngoiaoobsaeaa

boataanotesangingoata

agoatsanganoteinaboat

Each line contains the same twenty-one letters but they are arranged into three different orders. In the first line the letters are unrelated to those which precede or follow; therefore the memory span would have to hold and reproduce twenty-one items, a near impossible task. In line two, the letters are grouped into words: boat a a note sang in goat a. But because the words do not make any sense in immediate relation to each other, the memory would have to hold eight chunks in order to accurately reproduce all twenty-one letters which still exceeds the average capacity of the memory span. However, as soon as the reader recognizes and verbalizes the third line, it becomes easily memorized because the arrangement spells words which fit into one comprehensible phrase: "A goat sang a note in a boat." This necessitates holding only one chunk in the short-term memory, assuming that the words and the phrase are comprehensible because of information already assimilated into long-term memory. It is possible for an analogy to be made between this example and the music example above: in language, the words and sentences are to the letters, as, in music, the rhythm, tonality, and harmony are to the individual music tones.

Information in the long-term memory also was found crucial in a chess study which investigated the application of chunking to visual memory. Research focusing on the arrangement of chess pieces on a board shows that more experienced players can reproduce the arrangement of a chessboard better than weaker players because they can pack more chess pieces into a chunk. Familiarity with chess is clearly related to chunk size and immediate recall. In fact, over 75 percent of the chunks of master chess players fall into only three visual board patterns which are recalled through long-term memory schemas acquired by the study and experience of playing chess.[3]

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[3]William G. Chase and Herbert A. Simon, "Perception in Chess," *Cognitive Psychology* 4 (January 1973) : 55-81.

In his original report on chunking, Miller stated, "Since the memory span is a fixed number of chunks, we can increase the number of bits of information that it contains simply by building larger and larger chunks, each containing more information than before."[4] Subsequent to Miller's claim, Simon conducted experiments related to expanding chunk size. In large familiar phrases such as "Four score and seven years ago," he found that he could only remember three or four, therefore, concluding that chunk size is related to memory span. As chunk size increases in length and complexity, the memory item span may decrease to four or five instead of seven.[5] Of most importance, his findings confirmed that there are two conditions for estimating chunk size: one depends on knowledge of the previous experiences of the subjects, and the other depends on training procedures, in other words on experiences provided in the laboratory which "chunk" a maximum of data into a minimum of memory items. Frank Dempster, in a later report on memory span, also found that speed in identifying items is increased by chunked learning.[6] McBride, after several studies which spanned three years, concluded that chunking is more efficient than other methods of memorizing.[7] Wickelgren further clarified chunking as the basis of "semantic memory and cognitive learning"[8] because it is a means of consolidating memory. In chunking, "free" information forms strong associations to "set" information and becomes resistant to interference. This idea is supported in an experiment by Sternglass which describes students' ability to chunk sophisticated syntactic structures of grammar and sentence construction in expository writing.[9]

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[4]Miller, p. 93.

[5]Herbert A. Simon, "How Big Is a Chunk?" *Science* 183 (1974) : 487.

[6]Frank Dempster, "Memory Span: Sources of Individual and Developmental Differences," *Psychological Bulletin* 89 (January 1981) : 88.

[7]Susan McBride, and Francis Dwyer, *The Effect of Organizational Chunking and Retrieval Strategies in Facilitating Learning and Recall of Cognitive Learning Tasks* (Bethesda, MD: ERIC Document Reproduction Service, ED 223 202, 1982), p. 2.

[8]Wayne Wickelgren, "Chunking and Consolidation," *Psychological Review* 86 (January 1979) : 56.

[9]Marilyn Sternglass, *Creating the Memory of Unheard Sentences* (Bethesda, MD: ERIC Document Reproduction Service, ED 176 258, 1979).

Research about the chunking of sentences into syntactic phrases might offer some hints about the memory of musical phrases. Levelt, in 1970, attempted to prove that the phrase might be the natural unit, or chunk, of speech processing. Researchers superimposed clicks on recordings of continuous speech, and then asked subjects to report where they perceived the click to be.[10] The students had a tendency to dislocate the click toward the natural syntactic boundaries of the phrase. Balajthy, based on his 1974 research which monitored the eye movements of sixty tenth graders, also indicated the sentences are chunked into phrases during reading.[11]

However, similar research applying chunking in studies with younger children are mixed. Van Every and Rosenberg's 1969 study tested first - and seventh-graders on the effect of phrase structuring in sentences. The seventh-graders showed indications of using the chunking process, but the first-graders did not.[12] And in a 1980 study, Romberg and Collins found very few children (four- to eight-year olds) who were able to incorporate a strategy of chunking in a math test of digital placement.[13] Dempster suspects that there is little evidence that very young children use the chunking mechanism.[14] In fact in a 1978 study with seven- nine- and twelve-year olds, he discovered that normal age increase in memory span in middle childhood is due largely to chunking, indicating that chunking as a cognitive process is dependent not only on long-term memory but also to developmental age. However, Dempster's tests seem to focus on chunking which involves cognitive

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[10]W. J. M. Levelt, "Hierarchical Chunking in Sentence Processing," *Perception and Psychophysics* 8 (August 1970) : 99-103.

[11]Ernest P. Balajthy, Jr., *The Interaction of Eye-Voice Span with Syntactic Chunking and Predictability in Right- and Left-Embedded Sentences* (Bethesda, MD: ERIC Document Reproduction Service, ED 149 291, 1978), p. 14.

[12]Harolyn Van Every and Sheldon Rosenberg, *Semantics, Phrase Structure and Age as Variables in Sentence Recall* (Washington, D.C.: Office of Education, Bureau of Research, 1969), p. 365.

[13]Thomas A. Romberg and Kevin F. Collis, *The Assessment of Children's M-Space* (Washington, D.C.: Institute of Education, 1980) p. 74.

[14]Dempster, pp. 64 and 83.

processes as opposed to chunking which involves perceptual processes such as visual or auditory stimuli more relevant to musical perception.

Adler describes a successful habilitation program which used "musical" contour to improve linguistic skills in moderately and severely retarded children. The program stressed the development of auditory-visual storage and processing skills. Procedures involved using varied intonations of linguistic chunks in order to motivate the memory and repetition of spoken phrases.[15] Even though the students had extremely limited cognitive skills, they were successful in perceiving and responding to the "tonal" linguistic patterns, indicating that musical perception may involve different chunking processes.

Lutz's 1978 study attempted to show the abilities of chunking in the perceptual rather than the cognitive domain. Her research discovered implications about research involving split-brain patients. The right hemisphere is more holistic, taking in overall characteristics rather than specific details. In applying this research to the educational process, she suggested that creativity and "right-brain" thinking can be facilitated by using learning strategies such as "imagery, pictures, *chunking*, and analogies."[16] She maintained that chunking involves using the right hemisphere to see the Gestalt rather than continuing to focus on separate parts. Bower and Black identify story episodes as chunks in one's narrative memory. The length of the individual episodes affected the recall of details about the particular episode, but did not affect the memory of the other episodes. This study also implies that in the chunking process of memorization there are associative relationships made between the parts and the whole.[17] This reference to chunking as a perceptual and

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[15]Sol Adler, *A Habilitation Program for Children with Moderate, Severe and Profound Language Retardation: A Team Approach* (Bethesda, MD: ERIC Document Reproduction Service, ED 104 104, 1974), p. 2.

[16]Kathryn Lutz, *The Implications of Brain Research For Learning Strategies and Educational Practice* (Bethesda, MD: ERIC Document Reproduction Service, ED 164 068, 1978), p. 6.

[17]John Black, and Gordon Bower, "Episodes as Chunks in Narrative Memory," *Journal of Verbal Learning and Verbal Behavior* 18 (June 1979) : 311.

holistic learning process may have relevance to the memory and performance of musical information.

A myriad of studies followed in the 1970s and 80s in which researchers attempted to determine contextual clues in the learning process which would help students to chunk information in a variety of fields (see Table 2.1). Most of these studies dealt with

Table 2.1. Selected Studies on Chunking in Non-Music Fields

Year	Author	Findings	Source
1974	Roger Shuy	Found "fall off" of achievement after 1st yr. of reading because texts still concentrate on onset skills instead of using more appropriate chunking strategies	ERIC
1975 & 1979	James Furukawa, *et. al.*	Chunking strategies were applied to college study habits by means of a study outline.	ERIC
1976	Drew J. Arnolds Penelope H. Brooks	Chunking showed influence on children's listening skills.	*Journal of Ed. Psych.* 68 (Dec.) : 711-716
1977	Mary Ellen Sendak	Visually prechunked prose had an effect on the recall of reading content with 6-8th graders.	Ph.D. Diss. Fordham Univ.
1979	Martin Murphy, *et. al.*	Chunking improved study skills in the elderly.	DHEW
1979	Esther Valentine Olive Francks	Chunking to teach social studies concepts by compacting info. into more compact thought units.	*Reading Horizons* 20, (Fall) : 47-54
1980	Lisa Quinn	In developing reading skills with congenitally deaf, researchers used phonological chunking.	ERIC
1981	Kathleen Stevens	Chunking material as an aid to reading comprehension with 10th graders.	*Journal of Reading* 25 (Nov.) : 126-129
1984	Stacey Keenan	Chunking and shorter line length have positive effect on reading	*Visible Language* 18, (Winter) : 61-80

topics which are related to reading and math skills, very little of which has direct transferable implications to the organizational structures underlying musical perception. Nevertheless, in summarizing the literature review above, the following assumptions can be drawn and provide a premise upon which to discuss the application of chunking to music learning:

(1) Chunking works because it calls upon information already stored in the long-term memory. Using chunking in the learning process depends on two conditions

– knowledge of the previous experiences of the subjects, and the manipulation of training procedures to enable chunking.

(2) It is essential to identify the organizational structures in music which enable the process of chunking. In identifying these organizational structures, it may be possible to make some comparisons between language learning and musical learning, i.e., the words and sentences are to letters, as the rhythm, harmony, and tonality are to individual music tones.

(3) Chunking may involve focusing on music perception as a Gestalt rather than in separate learning parts because it is a hierarchical memory strategy.

(4) To initiate training procedures which enable chunking through the organizational structures of music, it seems reasonable to concentrate on fostering musical experiences which would improve aural music skills.

Musical Application

Chunking calls upon information already stored in the long-term memory.

Long-term memory acquisition has been a frequent subject in music education philosophy. Charles Leonhard in *Foundations and Principles of Music Education* states, "Concepts which emerge from a child's experiencing one song may be clarified and applied as he experiences other songs and other types of music."[18] Leonard Meyer in *Emotion and Meaning in Music* also agrees that what one knows influences what one perceives. And Bennett Reimer in *A Philosophy of Music Education* advocates a curricular pattern of experience, study, and re-experience.[19] In other words, students acquire musical

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[18]Charles Leonhard and Robert House, *Foundations and Principles of Music Education* (New York: McGraw-Hill, 1959), p. 77.

[19]Bennett Reimer, *A Philosophy of Music Education* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1970), p. 138.

experiences through listening and performance in order to build up long-term memory schemas of musical knowledge which can enable the chunking process in the memory and performance of melodic phrases. Leonhard and House write that "more commonly learning is the result of a more or less extended period of exploration of a given situation and the gradual emergence of meaning."[20] The words of James Mursell sum up this recursive emergence: "musical growth is the process of becoming musical."[21] However, music philosophers do not address the question of how previous musical information is transferred and used in processing new information.

An exploration of chunking through the writings of music psychologists may shed some light on the best types of experience to acquire in order to trigger the chunking mechanism and how this process is activated. There is little or no evidence of either individual or developmental differences in memory capacity. In fact Dempster claimed in 1981 that the only issues that remain concern the relationship between capacity and chunking,[22] and ten years later, those issues still are unresolved for music educators. Specifically, a more precise definition of what constitutes an "internal unit" is needed if more acceptable indices of musical capacity are to be discovered.

It is essential to identify organizational structures in music which enable "chunking."

Music theorist Otto Laske explored the relevance of Miller's research on chunking to the workings of the musical memory. He writes that, "it is the task of a theory of music to relate the knowledge we have about musical structures to our knowledge concerning the

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[20]Leonhard and House, 1959, p. 78.

[21]James L. Mursell, *Education for Musical Growth* (Boston: Ginn and Co., 1948), p.105.

[22]Dempster, p. 88.

mental processes and the memory system required for producing and /or understanding such structures."[23] He acknowledged that the short-term memory is of limited size and capacity and if overflow occurs in short-term memory while memorizing music, information will be lost. To avoid overflow, chunking uses a method called recoding which is possible only on the basis of stored semantic context functioning as a framework for selective perception and the modification of internal representations. In music, the use of melodic contour or harmonic density information for creating larger chunks in the short-term memory is an example of recoding.

Exactly in what way musical short-term memory differs from linguistic short-term memory is not precisely known at present. It seems clear from observations of musical experiences that the short-term memory for musical information is dynamic in size and may be determined by the interplay of processes in the neighboring, perceptual, and contextual memories that feed into it. Bartlett also agrees that, in general, the duration of sensory storage for sounds appears to be greater than that of visual sensory storage.[24] According to Klatzky, this may be because information in the short-term memory is coded acoustically, whereas long-term memory information is coded semantically.[25]

But of what elements does a musical chunk consist? Do tonal, rhythmic, and harmonic elements give an underlying subtext which helps the listener to pack more musical items into a chunk? Through a series of studies in the 1970s, Deutsch concluded "that tonal pitch deteriorates rapidly in the presence of other tones."[26] This seems to threaten the validity of chunking. However, in her studies she asked subjects to judge

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[23]Otto Laske, *Music, Memory, and Thought, Explorations in Cognitive Musicology* (Pittsburgh: University of Pittsburgh, University Microfilms International, 1977), p. 10.

[24]Dale Bartlett, "Tonal and Musical Memory," in *Handbook of Music Psychology,* ed. Donald A. Hodges (Lawrence, KS: National Association for Music Therapy, 1980), pp. 225-7.

[25]Roberta L. Klatzky, *Human Memory: Structures and Processes* (San Francisco: W. H. Freeman and Co., 1975), p. 250.

[26]Diana Deutsch, "Effect of Repetition of Standard and Comparison Tone on Recognition Memory for Pitch," *Journal of Experimental Psychology* 93 (April 1972) :162.

whether a test tone was the same as the standard tone. During the test, the standard tone was followed by either a series of spoken numbers or a series of musical tones which were unrelated to the standard tone, and subjects judged more correctly when interrupted by spoken numbers rather than intervening tones. The research indicated that they were unable to ignore the musical interruptions, indicating that pitch memory is dependent on other musical interactions and not merely short-term memory capacity. In other words, a series of unrelated musical pitches inhibit the recall of individual tones. On the contrary, research supports the hypothesis that tonal structure influences the memory of melodic sequences. In a 1975 study, Zenatti[27] found that tonal melodies were easier to recall than atonal ones, and Long[28] found that music majors made fewer errors in recalling brief melodies that were tonal rather than atonal in structure. This implies that tonal and harmonic structure is paramount to the memory of musical phrases, and perhaps, also, the meter and harmonic rhythm which defines cadences. It also may mean that music students should experience music holistically – that is, in its total context – as opposed to being exposed to isolated music elements during the learning process.

Music psychologists have striven to identify the organizational structure of musical perception through tests of musical aptitude. Seashore's research was the first to explore the definition of musical perception through his aptitude tests. In Seashore's era, based on the writing of Ebbinghaus, memory was believed to be dependent on capacity. A span of six different tones was about the limit that one could remember in Seashore's music aptitude tests.[29] However, it should be noted that this could be due to the fact that the patterns in his aptitude test did not contain familiar intervals and therefore could not be

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[27]Arlette Zenatti, "Melodic Memory Tests: A Comparison of Normal Children and Mental Defectives," *Journal of Research in Music Education* 23 (Spring 1975) : 41-52.

[28]Peggy A. Long, "Relationships between Pitch Memory in Short Melodies and Selected Factors," *Journal of Research in Music Education* 25, (Winter 1977) : 273-282.

[29]Carl Seashore, *The Psychology of Music Talent* (New York: McGraw-Hill Book Company, 1919); and Carl Seashore, *Psychology of Music* (New York: McGraw-Hill Book Company, 1938), p. 10.

chunked into perceived larger units. In fact, the aptitude tests of Kwalwasser-Dykema, and Drake use simple melodies in which the average memory span reported is twelve or more tones.

The most relevant of Seashore's concepts, which applies to the chunking process, is that of auditory imagery, which refers to mental tones which are heard in the imagination. He claimed, "The best-informed musicians agree that the power of imagery is one of the essential gifts of a musician."[30] In other words, musical imagery is the outstanding mark of a musical mind at the representation level. He explained that tonal imagery is a condition for learning, for retention, for recall, for recognition, and for the anticipation of musical facts. Tait reported on this "internal realization of music" as discussed by educational psychologists at the 1979 Ann Arbor Symposium on the applications of psychology to the teaching and learning of music, and its implication to music education.[31] Edwin Gordon, contemporary music psychologist, subsequently coined the term "audiation" which makes reference to Seashore's concept of "tonal imagery." Gordon believes that previous musical experiences are internalized through a process which he labels "audiation." He states that "to understand fully the music of a culture, a student must perceive, sensate, and audiate that music."[32] According to Gordon, children develop their own tonal and rhythmic syntax through what he terms as "music babble;" later children imitate the musical syntax of others around them. This thick description of a child's musical environment verifies the impact of experiencing music holistically. However, in the music classroom, Gordon advocates teaching the elements separately until music aptitude is stabilized at about age nine, and then, he claims, music aptitude is best measured in a total musical context.[33]

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[30]Seashore (1938), p. 223.

[31]Malcolm Tait, "Self in Sound: Properties and Qualities of the Musical Experience," *Music Educators Journal,* 67 (November 1980) : 50-51.

[32]Edwin E. Gordon, *Learning Sequences In Music* (Chicago: G.I.A. Publications, Inc., 1984), p. 26.

[33]Darrel L. Walters and Cynthia Crump, eds., *Readings in Music Learning Theory* (Chicago, IL: G.I.A. Publications, Inc., 1989), p. 37.

In any case, in order to explain tonal imagery ("audiation") in terms of the memory processes, one can say that in memorizing a melodic phrase, a musician must chunk its underlying structure – tonal, rhythmic, and harmonic – in order to recognize, recall, and repeat it. It seems, therefore, most likely that musical contexts which combine melody, rhythm and harmony provide the best experiences for developing auditory skills. Recent studies in melody retention support this theory. Jere Humphreys investigated music majors' ability to harmonize melodies and noted that melodic echo-playing ability was highly correlated with harmonic audiation.[34] Sandra Stauffer's study inferred that children improved singing ability more when melodies were heard in an harmonic context.[35] Also, Sterling concluded that subjects could sing melodies with greater accuracy while hearing tonal harmonic accompaniments.[36] And finally, Boyle and Lucas conclude that a tonal harmonic accompaniment does improve the sight singing accuracy of college music theory students, and cite studies which support similar research (Krumhansl, 1979; Cuddy, 1982, and Geringer, 1978).[37] The chunking of rhythmic phrases has also been investigated as a memory process in music and in other areas of learning. A 1987 study explored the effectiveness of "rap music" as a method of learning unfamiliar body parts. The rap music experimental group did retain more than the control group.[38] Rhyme and rhythm facilitated recall in teaching vocabulary to college students in an experiment which involved students

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[34]Jere T. Humphreys, "Measurement, Prediction, and Training of Harmonic Audiation and Performance Skills," *Journal of Research in Music Education* 34 (Fall 1986) : 192-99.

[35]Sandra L. Stauffer, "An Investigation of the Effects of Melodic and Harmonic Context on the Development of Singing Ability in Primary Grade Children" (Ph.D. dissertation, The University of Michigan, 1985).

[36]Pamela Ann Sterling, "The Effects of Accompanying Harmonic Context on Vocal Pitch Accuracy of a Melody," *Psychology of Music* 13 (April 1985) : 72-80.

[37]J. David Boyle and Keitha V. Lucas, "The Effect of Context of Sight Singing" *Council for Research in Music Education* 106 (Fall 1990) : 1-10.

[38]Patricia Thandi Hicks, "The Relationship Between an Oral Rhythmic Style of Communication (Rap Music) and Learning in the Urban Preschool," paper presented at the 70th annual meeting of the Association for Education in Journalism and Mass Communication, San Antonio, TX, August 1-4, 1987.

in writing song lyrics to a familiar tune.[39] In addition, Clifford Madsen and Myra Staum investigated the degree to which college students who were not music majors were able to discriminate between very similar melodies. Inferences indicated that the differences might be attributed to either mode (tonal context) or meter (rhythmic context).[40]

Chunking focuses on music perception as a Gestalt.

The idea of chunking, therefore, seems compatible with the theory that the attributes of music aptitude are holistic in nature. However, music psychologists are not in agreement among themselves about this concept. Despite his explanation of musical imagery which implies a composite gathering of musical sensations, Seashore disagreed with the holistic concept of music aptitude. He maintained that musical capacity was divided into a number of different and unrelated talents corresponding to the physical properties of sound: pitch, time, intensity and timbre. He believed that each one of these capacities was independent of the others. Other noted music psychologists such as Mainwaring and Bentley, who also piloted a variety of music aptitude testing, agreed that musical ability was composed of separate elements. In 1933, however, Drake developed the "integrative theory" which concludes that Seashore's taxonomy of specific talents might all be closely knit together by musical memory, consistent with Seashore's own theory of tonal imagery. Wing also ascertained that there is a general ability to perceive and appreciate music, in spite of his suspicion that a separate factor for rhythm might exist, though he obtained no evidence of it with his own test materials. Psychologists, McLeish (1950) and Shuter (1964) support Wing's view on the essential oneness of musical

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[39]Shirley Baechtold, and Ann Algier, "Teaching College Students Vocabulary with Rhyme, Rhythm, and Ritzy Characters," *Journal of Reading* 30 (December 1986) : 248-53.

[40]Clifford K. Madsen and Myra J. Staum, "Discrimination and Interference in the Recall of Melodic Stimuli," *Journal of Research in Music Education* 31 (Spring 1983) : 15-31.

ability.[41] Holmstrom (1963) argued for a number of group factors based on pitch, experience and memory, and intellectual factors.

Factor analyses for data from studies have indicated a correlation among musical memory, pitch, harmony, and to a lesser extent, rhythm. After rotation, musical memory tends to load with most other components of talent tests, and especially musical memory and pitch. Higher correlations have been found as early as 1941 by McLeish among pitch, harmony, and musical memory.[42] In terms of musical ability, the importance of memory is undeniable. In Drake's words, "Memory functions primarily to make it possible for the rendition of a piece to have unity, meaning, variety, and individuality. To interpret a composition intelligibly it is necessary to perceive the piece as a whole as well as the relationship of all the parts to each other."[43]

But a separate factor of rhythm seems to lurk in the shadows of several studies where tests of pitch and memory have been highlighted. This is acknowledged by both Karlin and Wing. McLeish (1950), Bentley (1955), and Rainbow (1965) have all shown that rhythm seems to be the "odd man out" in correlation studies. In a study focused on rhythm only, Zimmerman found that a child's rhythmic perception is dependent on a tendency to focus on the dominating rhythmic unit or grouping, so that rhythm seems to call upon its own properties in the chunking process.[44] Gordon's primary research in 1965 did find a close connection between the tonal and rhythmic part on his tests and has stated that "rhythm and melody interact in an inseparable way," but his tests of tempo and meter have only moderate correlations with his tonal tests.[45] On the other hand, French

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[41]Rosamond Shuter, *The Psychology of Musical Ability* (London: Methuen and Co. Ltd., 1968). p. 180.

[42]John McLeish, "The Validation of Seashore's Measures of Musical Talent by Factorial Methods," *British Journal of Psychology, Statistical Section* 3 (1950) : 129-140.

[43]Raleigh M. Drake, *Drake Musical Aptitude Tests* (Chicago: Science Research Associates, 1954), p. 8.

[44]Marilyn Phlederer Zimmerman, and Lee Sechrest, *How Children Conceptually Organize Musical Sounds* (Bethesda, MD.: ERIC Reproduction Service, ED 028 200, 1969), p. 2.

[45]Edwin E. Gordon, *Psychology of Music Teaching* (Englewood Cliffs, NJ: Prentice-Hall, 1971), p. 98.

music psychologist, Francés, claims that "centration" (meaningful perception) of tonal syntax is dependent on a strong harmonic context in which rhythmic factors also play a part.[46] Lastly, the results of a study by Duke and Pierce indicate that when the tempo was altered between the repetitions of musical passages by twenty-seven musicians at the University of Texas, accuracy of performance skills was drastically reduced, inferring finally, that rhythmic and tonal contexts are linked.[47]

Research also indicates that musical perception may be more holistically motivated in persons of high musical ability. Révész[48] found that musical children scored higher on a rhythm test when it was presented in the form of tunes, whereas unmusical children scored higher when the patterns were tapped. Assuming that the musical children had a richer musical background to draw from in long-term memory, this research may indicate that previous musical experiences enable the memory of musical patterns through the application of the chunking process to recall patterns in familiar contexts. Additionally, Mursell, Vernon, Wing and Révész all stress the importance of being able to perceive a tune as a whole rather than as a succession of notes in order to achieve a high level of musicianship. They feel that the totally unmusical person views a melody as a mere sum total of notes and fails to perceive it as a whole pattern. Research by Karma supports this suspicion. He found that persons who cannot perceive structure in music are likely to score lower on music aptitude tests.[49] Therefore, it would seem that it is not the total number of notes that is important in musical perception, but the complexity of the way in which pitches are classified and analyzed, in other words, chunked according to basic

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[46]Robert Francés, *The Perception of Music*, trans. W. Jay Dowling (New York: Laurence Erlbaus Associates, Publishers, 1988), p. 82.

[47]Robert A. Duke and Michael A. Pierce, "Effects of Tempo and Context on Transfer of Performance Skills," *Journal of Research in Music Education* 39 (Summer 1991) : 93-100.

[48]Géza Révész, *Introduction to the Psychology of Music*, trans. G. I. C. deCourcy (Norman, OK: University of Oklahoma Press, 1954), p. 231.

[49]Kai Karma, *The Ability to Structure Acoustic Material as a Measure of Musical Aptitude* (Bethesda, MD: ERIC Reproduction Service, ED196 743, 1981).

musical structuring elements. Shuter claims that the development of an ear for melody seems to depend largely on the establishment of a sense of tonality, and is in good company with current music education theorists, Froseth and Gordon. Additional information which validates the process of chunking can be found in the research of James Marquis (1963) at Iowa University, who concluded that ability to perceive the basic quality of intervals in melodic sight singing is considerably less important than ability to perceive the scale, harmonic, and tonal changes surrounding the intervals embedded in a melodic pattern.[50]

Chunking, as a Gestalt process, aids musicians in the memorization of pieces. Kovác's study has demonstrated that the most efficient memorization of musical material is always in terms of its sound. If a pupil can hear how a composition or a passage ought to sound – if he clearly grasps its tonal and rhythmic content – he has the most efficient possible memory and reproductive control of it.[51] Robert Lundin's research about how musicians memorize repertoire, summarized that learning by the whole method is recommended for short pieces. Previous studies by Rubin-Rabson, R. W. Brown,[52] and Eberly support this finding.[53] It seems that larger works are best memorized in smaller chunks. Lundin also found that practicing hands together was a more efficient way to learn a piece than practicing unilaterally, thus suggesting that musicians approach memorizing holistically.[54] And, in Heinlein's early memory research he suggested that one note could interfere with the memorization of an entire passage, because when altering one tone of a melodic sequence the "whole" is changed, and musical persons comprehend a sequence of

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[50]Shuter, p. 202.

[51] Leonhard and House, p. 246.

[52]Roberta W. Brown, "The Relation Between Two Methods of Learning Piano Music," *Journal of Experimental Psychology* 16 (June 1933) : 435-41.

[53] Grace Rubin-Rabson, "Studies in the Psychology of Memorizing Piano Music: A Comparison of Massed and Distributed Practice," *Journal of Educational Psychology* 31 (March 1940) : 270-84.

[54]Robert W. Lundin, *An Objective Psychology of Music* (New York: Ronald Press Company, 1953), p. 128.

tones as a totality with a characteristic constitutive contour rather than as separate tones.[55] Research by Davies and Jennings concludes that people have an internal representation or "template" of the tunes that they know, and a tune is recognized when it is sufficiently assimilated into this template. In other words, well-known tunes are not coded in memory in terms of differences between the pitches of the tones but as a whole pattern.[56]

Further research points to a holistic perception of melodic contour molded by the chunking process. Fritz Brehmer's study concludes that children respond to melody as a living totality not as a structure built out of notes – their mistakes are misapprehensions of the total melodic shape. His research shows that even when a melody is transposed to another key, very young children are not apt to recognize it at all. A study by Flowers and Dunne-Sousa also supports the theory that the melodic contour is perceived as a whole, not as individual notes. They found that children more accurately echoed melodic contours than correct pitches or intervals.[57] Also, in an article summarizing research on singing in the general music classroom, studies were cited that indicated children tended to be able to match pitch within patterns but were unable to match single pitches (Jones, 1971, and Madsen, Wolfe, Madsen, 1969). Therefore, children have more success with melodic patterns and songs than with single notes or scales, and the same source also indicated that there is some evidence that simple harmonic accompaniment seems to be beneficial to singing ability.[58]

In summary, the seeds of understanding chunking can be found in the research of music psychologists and music educators as it relates to a Gestalt theory of musical

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[55]Christian P. Heinlein, "A Brief Discussion of the Nature and Function of Melodic Configuration in Tonal Memory with Critical Reference to the Seashore Tonal Memory Test," *Journal of Genetic Psychology* 35 (March 1928) : 45-61.

[56]John Booth Davies *The Psychology of Music* (Stanford, CA: Stanford University Press, 1978), p. 145.

[57]Patricia J. Flowers and Deborah Dunne-Sousa, "Pitch-Pattern Accuracy, Tonality, and Vocal Range in Preschool Children's Singing," *Journal of Research in Music Education* 38 (Summer 1990) : 102-114.

[58]Mary Goetze, Nancy Cooper, and Carol J. Brown, "Recent Research on Singing in the General Music Classroom," *Council for Research in Music Education* 104 (Spring 1990) : 16-37.

perception. Music psychologists seem to be in agreement that musical perception is interpreted by an ability which can be described as musical imagery which implies a composite gathering of musical sensations, i.e., impressions received by the senses of hearing, sight, and the kinesthetic. Furthermore, this musical perception which, in turn, is manifested through listening, performing, and memorizing, is dependent on the ability to (1) perceive melody/rhythm as a whole, (2) sense the basic tonality, (3) perceive harmonic changes, and (4) process these perceptions through "chunking."

The "chunking process" is fostered by activating musical experiences and improving aural skills.

It can be therefore hypothesized that training procedures to enable chunking should concentrate on aural musicianship through gaining musical experiences in a holistic sensory context. Aural musicianship requires ample experience with melody, chords, rhythms, and pattern through listening, singing, playing, and creating. Studies support the premise that this type of training can make a difference in musical perception and musical aptitude. For example, Petzold, in an extensive study of children in the first six grades, found that tonal and rhythmic abilities depend largely on musical training and on musical experiences.[59] The quality and extent of musical experiences can be shown through Harrison's study which demonstrates that the best predictors of achievement, as manifested by grades in college freshman music theory classes, are academic ability and musical background experiences, specifically, piano study, and performance on more than one instrument.[60] Rainbow's factor analysis studied the impact of fourteen variables on musical

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[59]Robert G. Petzold, "The Development of Auditory Perception of Music Sound by Children in the First Six Grades" *Journal of Research in Music Education* 11 (Spring 1963) : 21-43.

[60]Carole S. Harrison, "Predicting Music Theory Grades: The Relative Efficiency of Academic Ability, Music Experience, and Musical Aptitude," *Journal of Research in Music Education* 38 (Summer 1990) : 124-137.

discrimination and found, in addition, that the background variables of home environment and the musical involvement of relatives were significant predictors.[61] Kehrberg's descriptive study of 169 fourth- through twelfth-graders also demonstrated that participation in musical experiences both inside and outside of school are strong predictors of general music achievement.[62]

Moreover, using Gestalt experiences to improve musical abilities is promoted by contemporary music educators and developmental learning theorists. The use of movement and creative play in the methods of Dalcroze, Orff, and Kodály promote an integrated system of bringing together elements in music education – singing, chanting, movement, aural training, instrumental study, and improvisation – that have too often been treated in isolation. These methods can be linked with cognitivists such as Piaget and Bruner who claim that the learner must experience music in order to understand a music concept, in lieu of describing concepts verbally. Music learning is a developmental process, based on experience, that causes a change in behavior.[63] Studies relevant to this topic have been produced by Hair (1977), Scott (1979), Webster and Scheintrick (1979).[64] Other integrative studies such as Shehan's indicate that both auditory and visual channels facilitate learning in musical rhythm.[65] In a 1989 study, Dunlap found positive correlations

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[61]Edward L. Rainbow, "A Pilot Study to Investigate the Constructs of Musical Aptitude" *Journal of Research in Music Education* 18 (Spring 1965) : 3-14.

[62]Donald Albert Kehrberg, "An Investigation of the Relationships Between Musical Aptitude, General Music Achievement, Attitude Toward Music, School Music Participation, School Music Achievement, and Students' Outside of School Environment in A Rural Ethnic Community" (Ph.D. dissertation, University of Illinois at Urban-Champaign, 1984).

[63]G. David Peters and Robert F. Miller, *Music Teaching and Learning* (New York: Longman Inc., 1982), p. 114.

[64] Harold F. Abeles, Charles Hoffer, and Robert Klotman, *Foundations of Music Education* (New York: Schirmer Books, 1984), pp. 171-2.

[65]Patricia Shehan, "Effects of Rote Versus Note Presentations on Rhythm Learning and Retention," *Journal of Research in Music Education* 35 (Summer 1987) : 117-26.

between vocal skills, instrumental performance and musical aptitude, and advocates combining instrumental practice and singing activities.[66]

A holistic musical environment should include experiencing music through sensory kinesthetic impressions which include movement, finger patterns, and other physical responses. Historically, music educators have incorporated movement into a program for developing basic musicianship. For example, John Curwen (1816-80) developed hand signs, a kinesthetic representations of pitch, to accompany solfege syllables. Dalcroze, who coined the term *eurhythmics* emphasized that students should not say, "I know," but "I feel,"[67] maintaining that the mind and body should function as a totality. Piaget found that if sensory-motor development was inhibited, later learning processes were also slower. Froseth's *Comprehensive Music Learning Sequence* includes movement in order "to develop the ability to synchronize movement to music and to prepare students for subsequent music performance and music reading activities."[68] In Boyle's 1968 music learning study, ten minutes of rhythmic movement training did improve students' sight singing skills.[69] A 1987 study showed that there is a correlation between music aptitude and motor development.[70]

Above all, listening is the basic music activity and it rightly pervades all others. The automatic memory mechanism of chunking can be promoted through auditory sensory impressions and non-verbal instruction . A study reported in 1988 found that listening only, without visual clues, was more effective than sight reading in detecting harmonic

[66]Michael Dunlap, "The Effects of Singing and Solmization Training on the Musical Achievement of Beginning Fifth-Grade Instrumental Students" (Ph.D. dissertation, The University of Michigan, 1989).

[67]Émile Jaques-Dalcroze, *Rhythm, Music, and Education,* trans. Harold F. Rubenstein (New York: Putnam's Sons, 1921), p. 43.

[68]James O. Froseth, *The Comprehensive Music Learning Sequence: Teacher Planning Guide* (Chicago: G.I.A. Publications, Inc., 1984), p. 1.

[69]J. David Boyle, "The Effect of Prescribed Rhythmical Movements on the Ability to Sight Read Music" (Ph.D. dissertation, University of Kansas, 1968), p. 20 & 81.

[70]Dale Baer, "Motor Skill Proficiency: Its Relationship to Instrumental Music Performance Achievement and Music Aptitude" (Ph.D. dissertation, The University of Michigan, 1987).

alterations in several examples from piano music.[71] Performance and active listening through imitation and modeling promotes music understanding through holistic sensory experiencing. Peters writes that the majority of education is not at all formal but the natural outgrowth of modeling born through a mimicking of attitudes and actions. "You learn to do what you do, not something else."[72] Therefore, the power of education by modeling is tremendous.[73] A study on the effect of model-supportive practice indicates that a take-home practice model tape which the student listens to improves performance. By contrast, further practice without listening did not substantially raise achievement.[74] Froseth's *MLR Aural Skills Training Series* is based on the idea that music is composed of rhythmic patterns and melodic patterns.[75] Therefore, the teacher, in the role of performer and model, must help students to perform and to read rhythmic patterns and melodic patterns and then direct students to use the patterns they have learned to sing and play independently. Through imitation, students learn to analyze music for rhythmic patterns and melodic patterns, generalize previously learned musical concepts and skills, and, finally, to synthesize all elements into a musically proficient performance: "students learn to play what they hear and hear what they see."[76] Wilder found that this training, the *MLR Melodic Ear-to-Hand Skills Program* which is part of the *MLR Aural, Visual and Kinesthetic Skills Training Series*, significantly improved aural musicianship in college freshmen. His study also concluded that grades in theory classes were highly correlated

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[71]Gail de Stwolinski, James Faulconer, and A. B. Schwarzkopf, "A Comparison of Two Approaches to Learning to Detect Harmonic Alterations," *Journal of Research in Music Education* 36 (Summer 1988) : 83-94.

[72]Glenn M. Blair; R. Stewart Jones; and Ray H. Simpson, *Educational Psychology* (New York: Macmillan Company, 1968), p. 115.

[73]G. David Peters and Robert F. Miller, *Music Teaching and Learning* (New York: Longman Inc., 1982), pp. 5-6.

[74]William Zurcher, "The Effect of Model-Supportive Practice on Beginning Brass Instrumentalists" (Ed.D. Dissertation, Columbia University Teachers College, 1972).

[76]James O. Froseth, *MLR Aural, Visual and Kinesthetic Skills Training Series* (Chicago: G.I.A. Publications, 1985).

with melodic ear-to-hand coordination.[77] In a study comparing verbal instruction and nonverbal teacher-student modeling, Dickey found that students that received the modeling instruction achieved significantly higher scores on a test of aural skills. The results suggested that music discrimination is not effectively taught through verbal description.[78] A earlier study by Delzell also concluded that musical discrimination skills can be developed in beginning instrumental students by systematic training which includes modeling and imitation.[79] Furthermore, in terms of teacher competencies necessary for training music students, Sang's path analysis indicated that modeling skill is the greatest single contributor to variance in instructional effectiveness.[80]

Summary

Chunking calls upon information already stored in the long-term memory to analyze and assimilate new musical material. Therefore previous musical experiences greatly impact a person's ability to chunk in the memory and performance of melodic patterns. According to existing research, it is hypothesized that the structuring devices which enable chunking to recode information into subsets are pitch, rhythm, tonality, and harmony. Chunking focuses on music perception as a Gestalt rather than in separate learning parts. Through experiences which are kinesthetic, auditory, and visual in nature, the patterns for the chunking process are developed which enable students to achieve a high level of musical perception, musical performance, and musical memory. Therefore, in order to

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[77]Michael Wilder, "An Investigation of the Relationship Between Melodic Ear-to-Hand Coordination and Written and Aural Theory Skills within an Undergraduate Music Theory Context" (Ph.D. dissertation, The University of Michigan, 1988).

[78]Marc R. Dickey, "A Comparison of Verbal Instruction and Nonverbal Teacher-Student Modeling in Instrumental Ensembles," *Journal of Research in Music Education* 39 (Summer 1991) : 132-142.

[79]Judith K. Delzell "The Effects of Musical Discrimination Training in Beginning Instrumental Music Classes," *Journal of Research in Music Education* 37 (Spring 1989) : 21-31.

[80]Richard Sang, "Modified Path Analysis of a Skills-Based Instructional Effectiveness Model for Beginning Teachers in Instrumental Music Education" (Ph.D. dissertation, The University of Michigan, 1982), p. 3.

devise a training program in which students will apply the chunking mechanism to the memory performance of melodic phrases it is hypothesized that the following conditions will be most beneficial: (1) The melodies should be presented in a holistic music context which includes tonality, rhythm, and harmony; (2) the students should both listen and respond, through non-verbal modeling and imitation, to patterns nested in an aural training tape; (3) they should respond by playing back what they hear in order to develop ear-to-hand coordination in which the kinesthetic sense also plays an essential part in musical perception.

CHAPTER III

METHODOLOGY

Hypotheses

This experiment was launched in order to investigate which types of musical experiences account for the greatest differences in chunking ability. Two hypotheses were tested in an quasi-experimental setting which predicted the outcome for the following research question. In which experimental group can the reductive information process of chunking be triggered in order to best increase the memory and performance of melodic patterns: (1) in a treatment group which practices melodic patterns accompanied by a rhythmic and harmonic background (MRH) ; (2) in a treatment group which practices melodic patterns accompanied by a rhythmic background (MR) ; (3) in a treatment group which practices unaccompanied melodic patterns (M); or (4) in a control group which receives no group practice sessions (C).[1]

Hypothesis #1 of this experiment predicts that the MRH group which practiced patterns set in a holistic music context would be most effective in increasing the memory and performance of melodic patterns as measured by a posttest instrument designed to diagnose aural skills. Likewise the MR group was predicted to be more effective than the melody only (M) or control (C) group. This study, therefore, attempted to reject a null hypothesis which predicted no significant ($p < 0.05$) difference between the mean posttest score measures of each group after adjustments had been made for a pretest measure of

[1]Glossary of group labels: MRH = Melody with rhythm and harmony group; MR = Melody with rhythm group; M = unaccompanied melody group; C = control group.

aural skills and background variables:[2]

$$H_0: \mu_{(MRH)} = \mu_{(MR)} = \mu_{(M)} = \mu_{(C)}$$

The null hypothesis was tested against an alternative hypothesis in order to infer that a significant ($p < 0.05$) difference would be predicted between the mean posttest score of each group after adjustments had been made for pretest scores and background variables:

$$H_a: \mu_{(MRH)} \neq \mu_{(MR)} \neq \mu_{(M)} \neq \mu_{(C)}$$

Hypothesis #2 predicts that the previous musical background of each student, reported in a survey questionnaire, might also have a significant impact on chunking abilities since chunking depends upon familiarity with related memory structures stored in the long-term memory. Therefore, a second null hypothesis predicted that there would be no significant effect of musical background variables as measured by the posttest scores.[3]

$$H_0: \alpha_{\text{musical background}} = 0$$

Likewise, the null hypothesis was tested against an alternative hypothesis in order to infer that musical background had a significant effect on the student's chunking ability of melodic phrases as measured by the posttest.

$$H_a: \alpha_{\text{musical background}} \neq 0$$

The procedure for testing these null hypotheses in an experimental setting consisted of five phases: (1) selection of the research sample; (2) preparation of treatment tapes; (3) selection of a diagnostic test for pre- and posttesting; (4) distribution of a student survey questionnaire to analyze background data; (5) administration of the treatment; and (6) analysis of the results.

Research Sample; N=60

The research sample for this experiment consisted of first semester freshmen music majors who were enrolled in four Level I theory skills classes at Indiana University of

[2] μ signifies group mean
[3] α = score effect

Pennsylvania. This course was chosen as the arena for this experiment for the following reasons: (1) because it is a required course for all music majors and it is elected during the first semester of the freshman year, it offered the best opportunity to maximize the number of beginning college music students involved in the experiment; (2) the content of both the sight singing and ear training portions of the theory skills class is well suited to the skills which were required to practice the training tapes in this experiment; and (3) there were a total of four sections of theory skills at IUP, exactly the number of classes necessary for the treatment and control groups.

Theory skills is a three-credit laboratory course which meets three hours weekly and is elected concurrently with the required freshman theory course. Both classes meet one hour each on Monday, Wednesday, and Friday for fifteen weeks. The goal of the theory skills class is to improve aural musicianship through sight singing and ear training activities. A text book for each area – sight singing and ear training – is used for this course.[4] The first semester of theory skills covers Section I of *A New Approach to Sight Singing*,[5] by Berkowitz, Fontrier and Kraft. This section is composed of melodies, themes and variations, duets, play-and-sing exercises, and improvisational studies in which the students practice singing at sight. The melodies are diatonic and are based upon both major and minor modes set in a variety of meters, key signatures, tempi, dynamics and clefs. As a follow-up, students are encouraged to also play the melodies which have been sung in class. Melodies begin in stepwise motion, and then advance to skips through arpeggiations of the tonic, dominant and subdominant chords.

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[4]Theory Skills is elected concurrently with the freshman basic theory course which uses the following text: Bruce Benward, *Music in Theory and Practice* (Dubuque, IA: W.C. Brown Company Publishers, 1977).

[5]Sol Berkowitz; Gabriel Fontrier; and Leo Kraft, *A New Approach to Sight Singing*, 2nd Edition (New York: W. W. Norton and Company, 1976).

The other text is Bruce Benward's *Ear Training: A Technique for Listening.* [6] Semester one covers half of the text which consists of eight melodic, harmonic, and rhythmic units. These units include written and aural exercises covering a wide variety of content. The melody units include: major scales and all three forms of the minor scales; intervals; the church modes and other scale forms; and melodic dictation. The rhythm unit covers note values, duple, triple and mixed meters. The harmony unit includes major, minor, diminished and augmented triads, a description of diatonic triads, and basic cadential progressions using I, IV, and V chords.

At the beginning of the experiment there were seventy-five students enrolled in the classes as follows: twenty each in sections one and two; fourteen in section three, and twenty-one in section four. Sixty students were retained in the experiment for analysis: section one; N=18; section two, N=13; section three, N=12, and section four, N=17. The other students were dropped from the study for the following reasons. Ten students withdrew from the class or dematriculated from the university, and five students were disqualified on the basis of low attendance. Insufficient attendance was defined as that which fell one standard deviation below the mean which was 69% with a standard deviation of 23% (see Table 3.1).

Table 3.1. Total Attendance

Mean:	Std. Dev.	Coef. Var.:	Count:
69.4%	22.7	32.9	65

In summary, the research sample can be described as follows: beginning college music students enrolled in four groups of theory skills courses designed to improve aural skills through melodic and rhythmic dictation, and through the aural study of chord qualities and the recognition of simple cadences based on primary chords.

[6]Bruce Benward, *Ear Training: A Technique for Listening*, 2nd Edition (Dubuque, IA: W.C. Brown Company Publishers, 1983).

Treatment Tapes

Three sets of training tapes were prepared to practice the memory and performance of a variety of melodic patterns. As aforementioned, chunking calls upon familiar contextual structuring devices which have been stored in the long-term memory in order to link numerous items into one memory unit of the short-term memory. A review of the literature in chapter 2 revealed that there is a correlation among musical memory, and perception of pitch, harmony, and rhythm. Therefore, the structuring devices in the musical memory can be defined as melody, rhythm, and harmony. In keeping with this theory, each treatment differed on the amount and type of contextual information given with a series of melodic patterns. In the holistic context – melody, rhythm, and harmony (MRH) – a short melody was accompanied by chords and a rhythm section. In the melody and rhythm context (MR), the same melody was accompanied by a rhythm section; and in the melody context (M), only the tune was heard without any other accompaniment.

Each tape was scripted with the following introduction in order to provide sufficient information to the students without giving away the intent of the experiment:

> "The purpose of this training tape is to develop skills in aural musicianship by imitating melodic patterns based on primary chords in major and minor tonalities. This tape is easy to use. First you will hear a short melodic introduction, then you will hear a sequence of melodic patterns. Your task is to imitate each melodic pattern on the keyboard right after you hear it, and in the same time-frame. You will be given the starting tone of the first pattern in every sequence. You may imitate the pattern at any octave and with either the right or the left hand.
> Each tape is approximately ten minutes long. You will have an opportunity to practice each tape three times before moving on to the next set of sequences."[7]

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[7]see Tape Script in Appendix D, pp. 147-153.

Then the starting note was given for each sequence, and the tonal center was established by playing the tonic arpeggio before each exercise. For the MRH, and MR treatments, the accompaniment was added by means of a synthesizer with MIDI capabilities through a Macintosh-compatible computer software program.[8] Each accompaniment line was recorded on a separate track in order to ensure balance between the melody and accompaniment. The melody was recorded on a solo instrument (for example, brass or reeds); the rhythm track was added by a drum machine; and the harmony consisted of two tracks – a bass line which outlined the chord roots, and a piano track which arpeggiated the chords.

Twelve tapes were prepared to use during the twelve weeks of the experiment. Each tape was intended to be practiced for three ten-minute sessions during the Monday, Wednesday, and Friday class periods. In preparing the tapes, an attempt was made to parallel the content of both the sight singing and ear training portions of the theory skills course as described above. The melody patterns are based on primary chords – I, IV and V7 – in major and minor tonalities, which are consistent with the harmony units in the ear training text. The patterns are all four beats long in either duple or triple meter. The information "chunked" in each pattern increased in size and complexity as the experiment progressed. For example, the number of notes and rhythmic complexity increased as well as the number of chords in the harmonic progressions of each pattern. The components of this sequential process are also reflected in the theories of Gordon which ascertain that there are hierarchical levels of learning sequences through which students acquire proficiency in aural musicianship. At Gordon's basic tonal and rhythmic levels, students must be able to hear and perform melodic patterns in major and minor tonalities and at the tonic and dominant level, and rhythmic patterns in duple and triple meter.[9]

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[8]Professional Composer Ver. 2.3 (Cambridge, MA: Mark of the Unicorn, Inc., 1988); and Professional Performer Ver. 3.2 (Cambridge, MA: Mark of the Unicorn, Inc., 1989).

[9]Edwin Gordon, *Learning Sequences in Music: Skill, Content, and Patterns* (Chicago: G.I.A. Publications, Inc., 1988) p. 63.

Each tape contained four to six sets of patterns which were composed of the same scale degrees and in which the starting note was the same. The keys of C-major and A-minor were exclusively used in the first six weeks of practice because they were technically the easiest to perform on the piano. Patterns were generally introduced first in the major key, and the set which followed used similar patterns in the relative minor key. For example, tape one contained five sets of patterns introduced as follows, "This is Tape 1, Set A, melodic patterns composed of the first, second, third, fourth, and fifth degrees of the C-major scale. The starting tone of the first pattern is C." Set B was composed of the same scale degrees in the key of A-minor with the starting note of A. The patterns in all five sets ("A" through "E") on Tape one are centered around the tonic and dominant-seventh chords, and contain six notes of the C-major or A-minor scales – the leading tone and first five scale degrees.

All patterns are based on the *MLR Melodic-Ear-to-Hand Skills Program* [10] tapes to develop aural musicianship, developed by James Froseth, Levels I-IV. Froseth's *Comprehensive Music Instructor* [11] is based on the idea that music is composed of rhythmic patterns and melodic patterns, which is also consistent with Gordon's Music Learning Theory philosophies.[12] Froseth believes that through listening and performing rhythmic and melodic patterns, students acquire aural skills through self-initiated and self-directed study. The patterns in *MLR Melodic Ear-to-Hand Skills Program*, an aural training program designed to develop a student's ability to recognize and repeat melodic phrases, contain skill levels which mirror the content of beginning freshman theory classes.[13]

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[10] James O. Froseth, *MLR Aural, Visual and Kinesthetic Skills Training* (Chicago: G.I.A. Publications, Inc., 1985).

[11] _______, *The Comprehensive Music Instructor, Listen, Move, Sing, and Play*, brochure (Chicago: G.I.A. Pubiications, Inc., 1985).

[12] Gordon, p. 3.

[13] see Froseth, Chapter 2, p. 33.

In this experiment, Tapes 1 to 3 are examples from Level I of the *MLR Skills Program*.[14] Figure 3.1 shows an example from Tape 1, Set A, in duple meter and major mode. Figure 3.2 is an example from Tape 1, Set B, which is composed of the same duple patterns in the minor key. Figures 3.3 and 3.4 show examples from the same tape in triple meter.

Tape 2 contains melodic patterns composed of the tonic chord in the various inversions and in both major and minor modes (see Figures 3.5 -3.7). The patterns in Tape 3 are composed of arpeggiated patterns which outline primary chord progressions. For example, Figures 3.8 and 3.9 show examples of melodic patterns derived from the harmonic progression I -V7 or V7 - I. Longer melodic patterns are shown in Figures 3.10 and 3.11, which are derived from the chord progression: I - IV - V7 - I in both C-major and A-minor.

Beginning with Set C, Tape 4, the patterns are based on Level II of Froseth's *MLR Melodic Ear-to-Hand Skills Program.* Tapes 4-6 are composed of melodic patterns in all major keys derived from the harmonic relationship between the dominant-seventh chord and the tonic triad. Each pattern begins on the fifth scale degree, or "G" in C-major. Figure 3.12 demonstrates how the patterns progress through the circle of the fifths on Set C, Tape 4, and includes the rhythmic and harmonic backgrounds. Figure 3.13 shows the first two sequences of the subsequent patterns through Tape 6. The accompaniment on the tapes with rhythmic or rhythmic and harmonic background is the same as the accompaniment shown in Figure 3.12.

Tapes 7 - 9 are designed to be used during the seventh through ninth week of the experiment. The patterns on these tapes are based on Level III of the Froseth training series. Basically, the patterns are similar to Level II, except that they are set in the minor tonality. They are composed of melodic patterns in all minor keys derived from the

[14]see Figures 3.1 - 3.17, pp. 45-63, which give examples of the melodic patterns included in the treatment tapes.

harmonic relationship between the dominant-seventh chord and the tonic triad built on the first degree of the minor scale. Both the harmonic and melodic scale forms are used in the patterns. The verbal instructions in the taped introduction always indicates the starting tone (the fifth scale degree - E) as well as the appropriate form of the minor scale. Figure 3.14, which is from Tape 7, Set A, shows the rhythmic and harmonic background, and demonstrates how the patterns progress through the circle of the fifths starting with A-minor and ending with E-minor. Figure 3.15 shows the first two sequences of the subsequent minor patterns through Tape 9.

Tapes 10 through 12 are practiced during the remaining weeks of the experiment. These tapes are based on Levels IV and V of the *MLR Melodic Ear-to-Hand Skills Program.* They are composed of melodic patterns in all keys derived from the harmonic relationship between the tonic and the subdominant triads. The patterns were practiced in every key by moving downward through the circle of fifths. Figure 3.16 shows the accompaniment which provided the background for the rhythmic and harmonic treatment tapes. The example from Tape 10, Set A, is the first melodic pattern and accompaniment for the major keys, and the example from Tape 12, Set A, is the first melodic pattern and accompaniment for the minor keys. Figure 3.17 shows the first two sequences of the major and minor melodic patterns practiced in Tapes 10 through 12. The starting note for each pattern begins on the first scale degree. Therefore, the major key sequences begin on "C" and proceed through major keys F, B^b, etc., ending with G. The minor sequences begin in A-minor and circle through D-minor, G-minor, etc., and end with E-minor.

In summary, twelve treatment tapes were prepared, one for each week of class. The tapes are based on the tonal and rhythmic taxonomy in Froseth's *MLR Melodic-Ear-to-Hand Skills Program,* and are consistent with Gordon's Music Learning Theory levels. They were also designed to parallel the content of the theory class, as well as inducing the automatic memory structuring process of chunking to reorder the patterns into one memory chunk according to their rhythmic and harmonic textures.

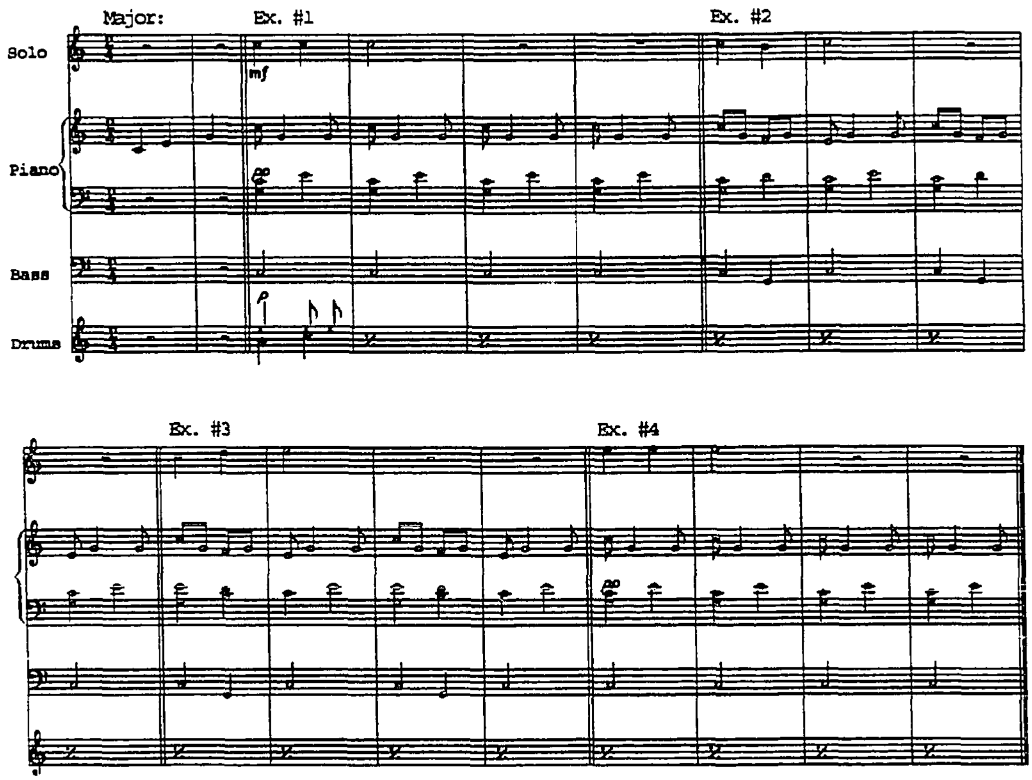

Figure 3.1. Tape 1, Set A
Duple Meter in C-Major

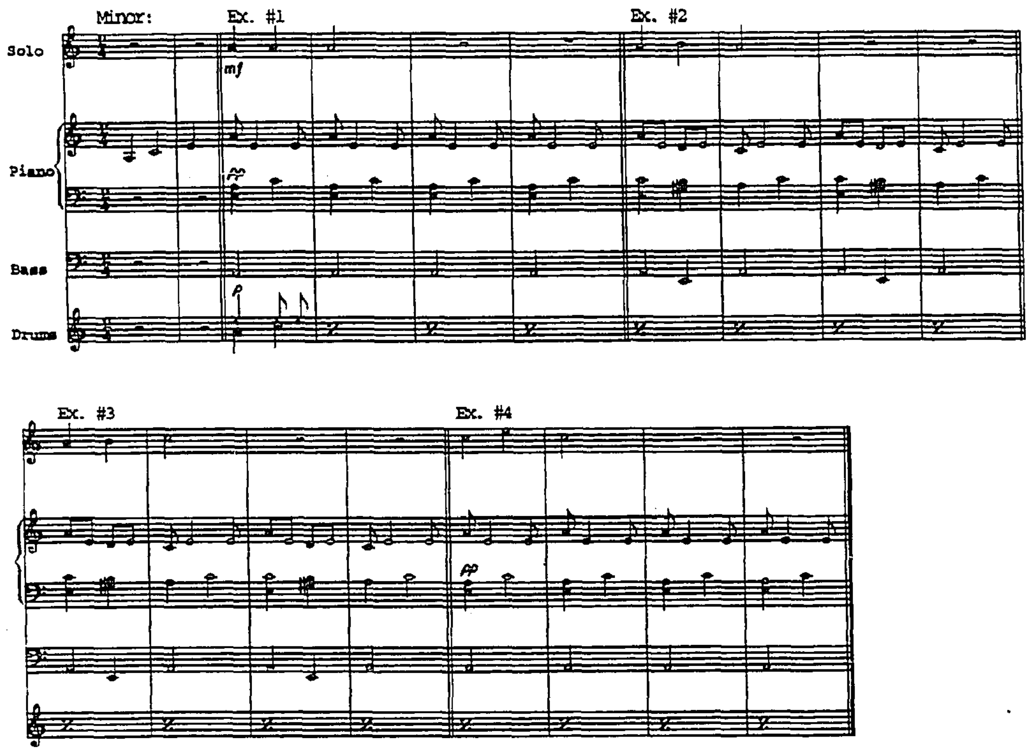

Figure 3.2. Tape 1, Set B
Duple Meter in A-Minor

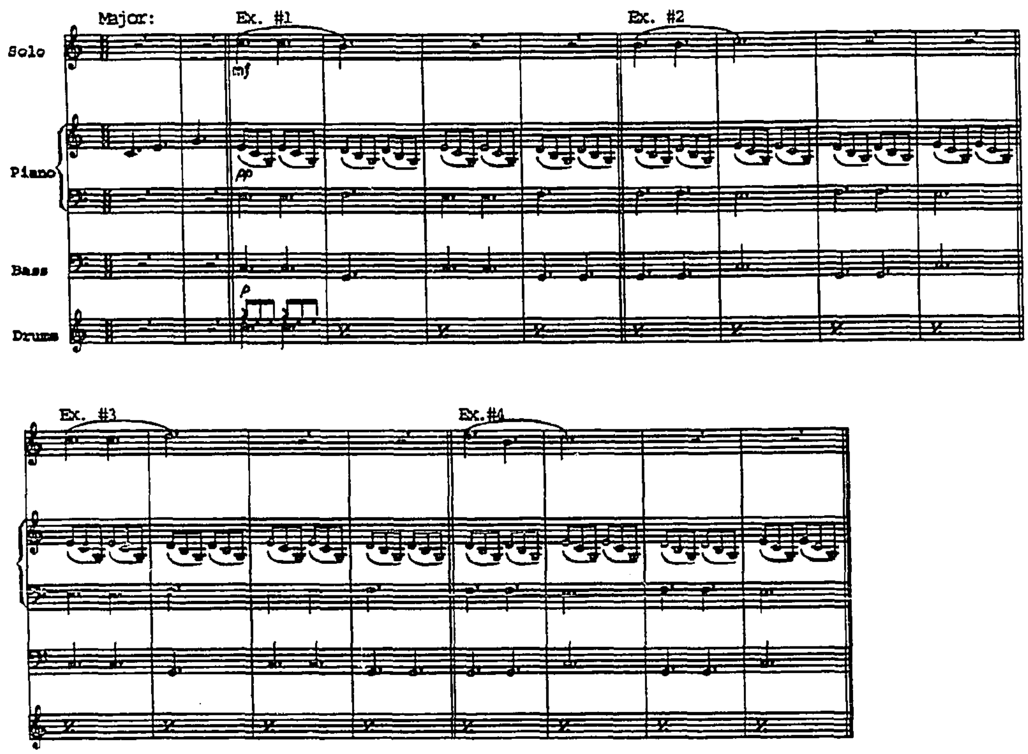

Figure 3.3. Tape 1, Set C
Triple Meter in C-Major

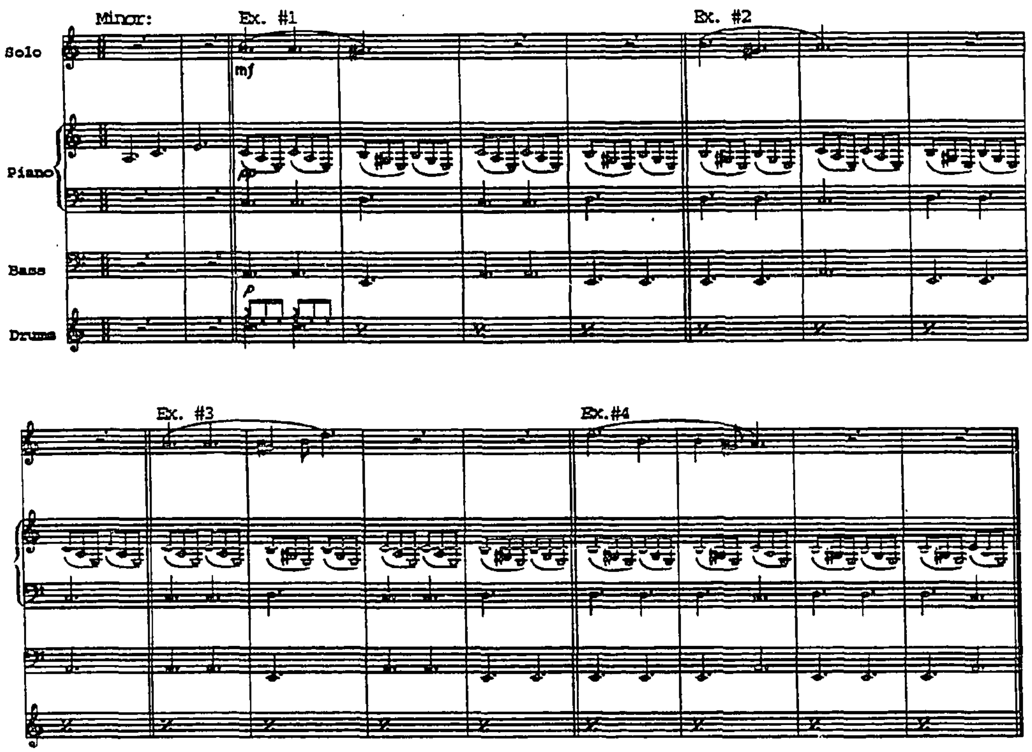

Figure 3.4. Tape 1, Set D
Triple Meter in A-Minor

Figure 3.5. Tape 2, Sets A and D
Melodic Patterns Based on Tonic Arpeggios in C-Major and A-Minor

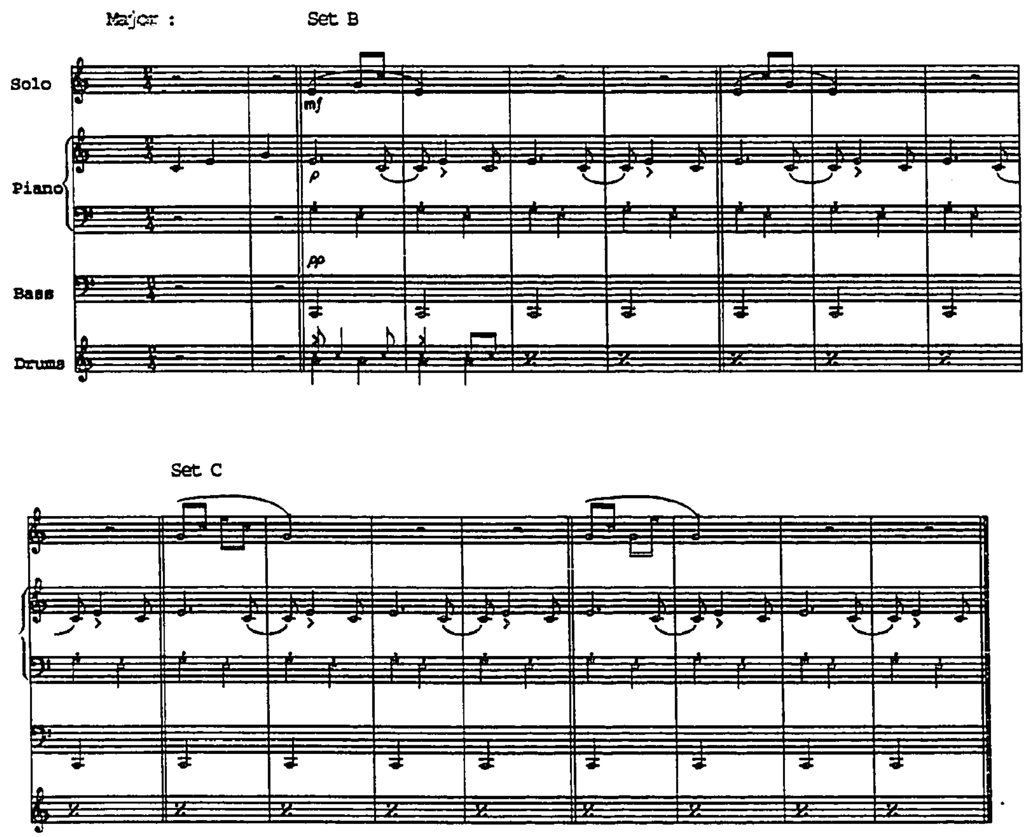

Figure 3.6. Tape 2, Sets B and C
Melodic Patterns Based on Tonic Arpeggio Inversions in C-Major

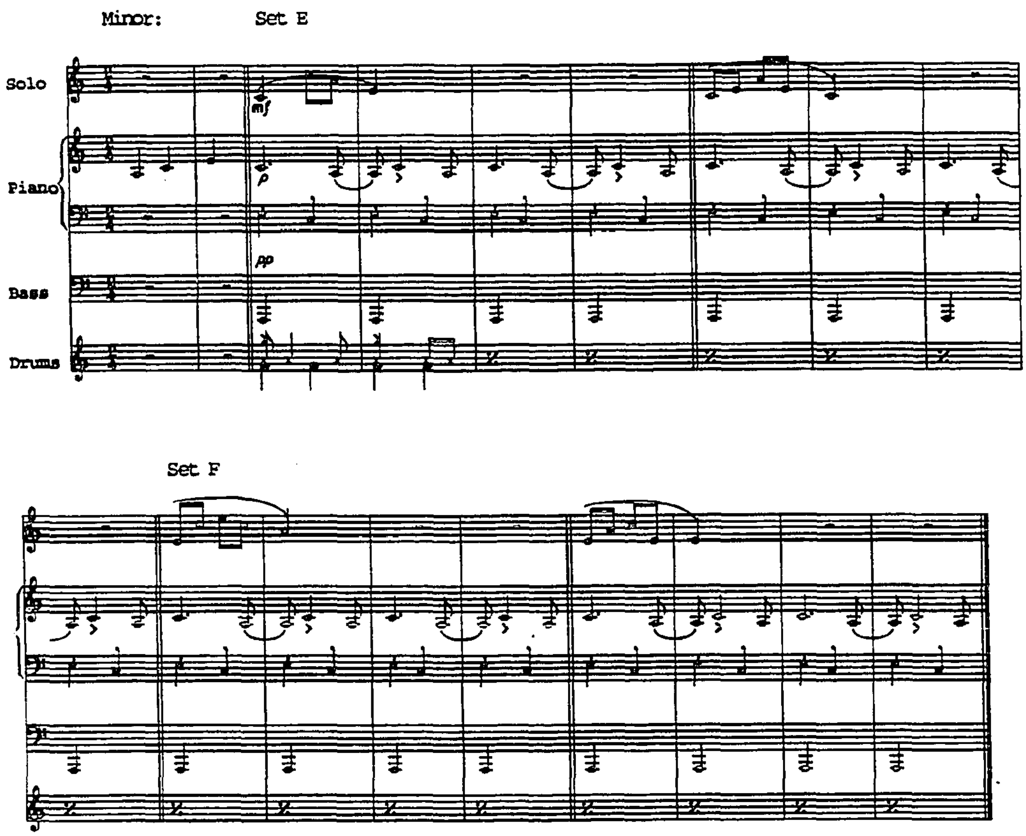

Figure 3.7. Tape 2, Sets E and F
Melodic Patterns Based on Tonic Arpeggio Inversions in A-Minor

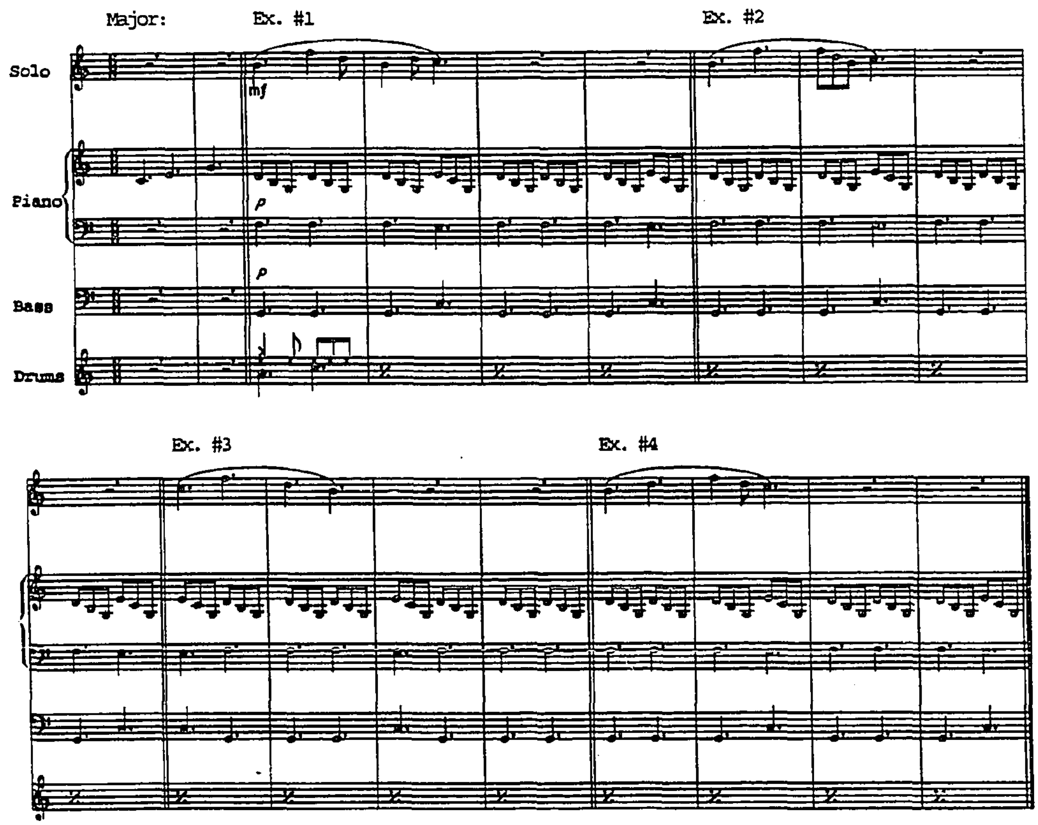

Figure 3.8. Tape 3, Set A
Melodic Patterns Based on I and V^7 Arpeggios in C-Major

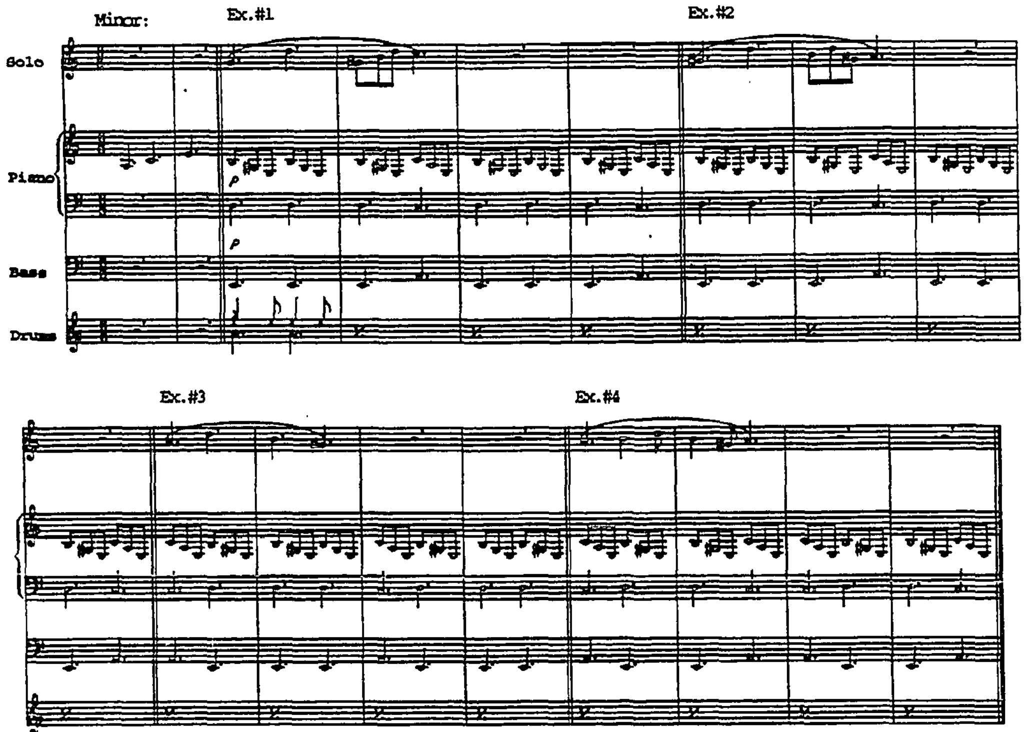

Figure 3.9. Tape 3, Set C
Melodic Patterns Based on I and V^7 Arpeggios in A-Minor

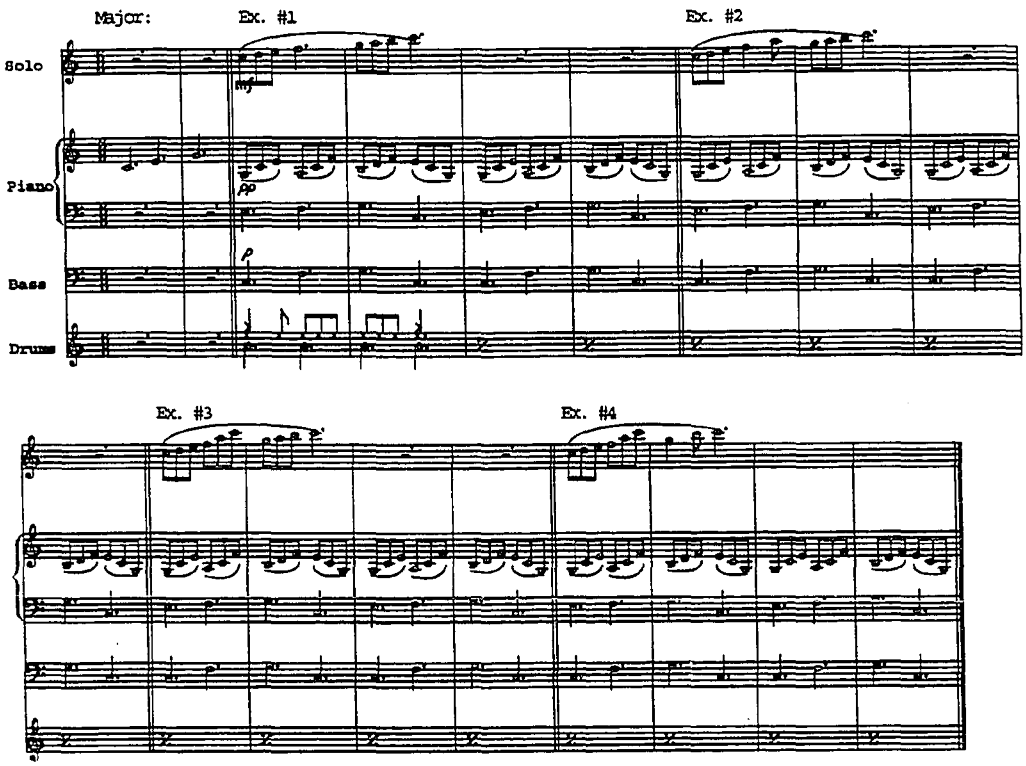

Figure 3.10. Tape 3, Set D
Melodic Patterns Based on the Harmonic Progression I-IV-V^7 in C-Major

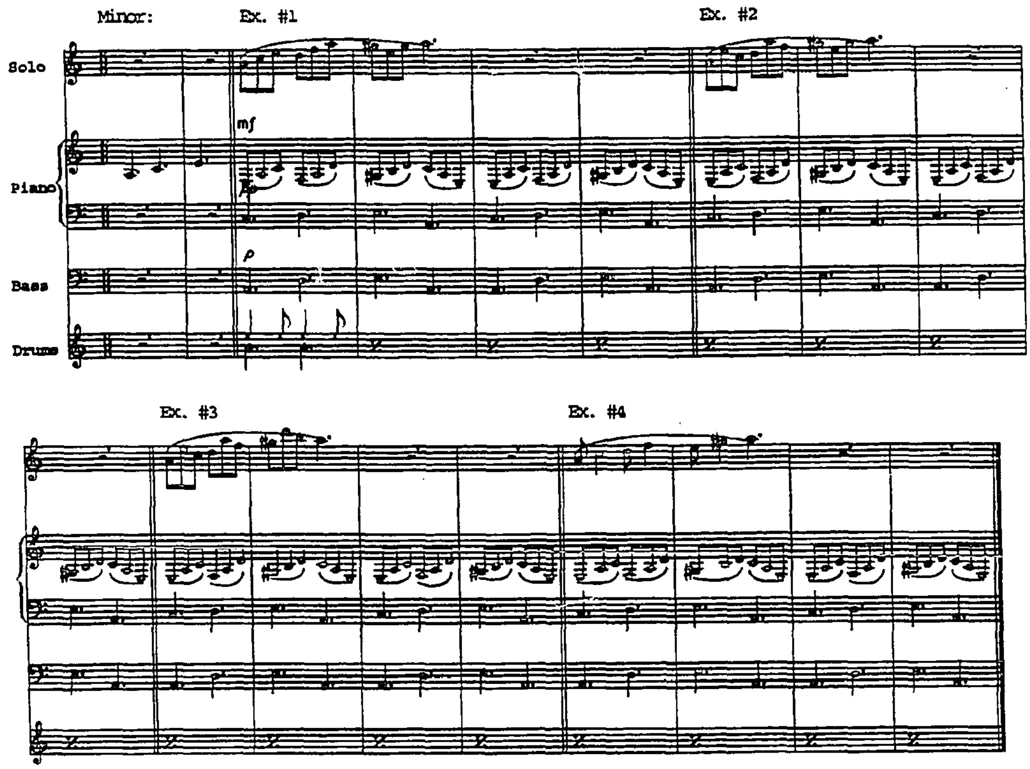

Figure 3.11. Tape 3, Set E
Melodic Patterns Based on the Harmonic Progression I-IV-V^7 in A-Minor

Figure 3.12. Tape 4, Set C
Melodic Patterns in All Major Keys Based on the V7 and I Chords with Accompaniment Pattern

Figure 3.12. (continued)

Figure 3.13. Tapes 4-6
Melodic Patterns in All Major Keys Based on I and V⁷ Chords
(first two examples in each set)

Figure 3.14. Tape 7, Set A
Melodic Patterns in All Minor Keys Based on I and V^7 Chords with Accompaniment Pattern

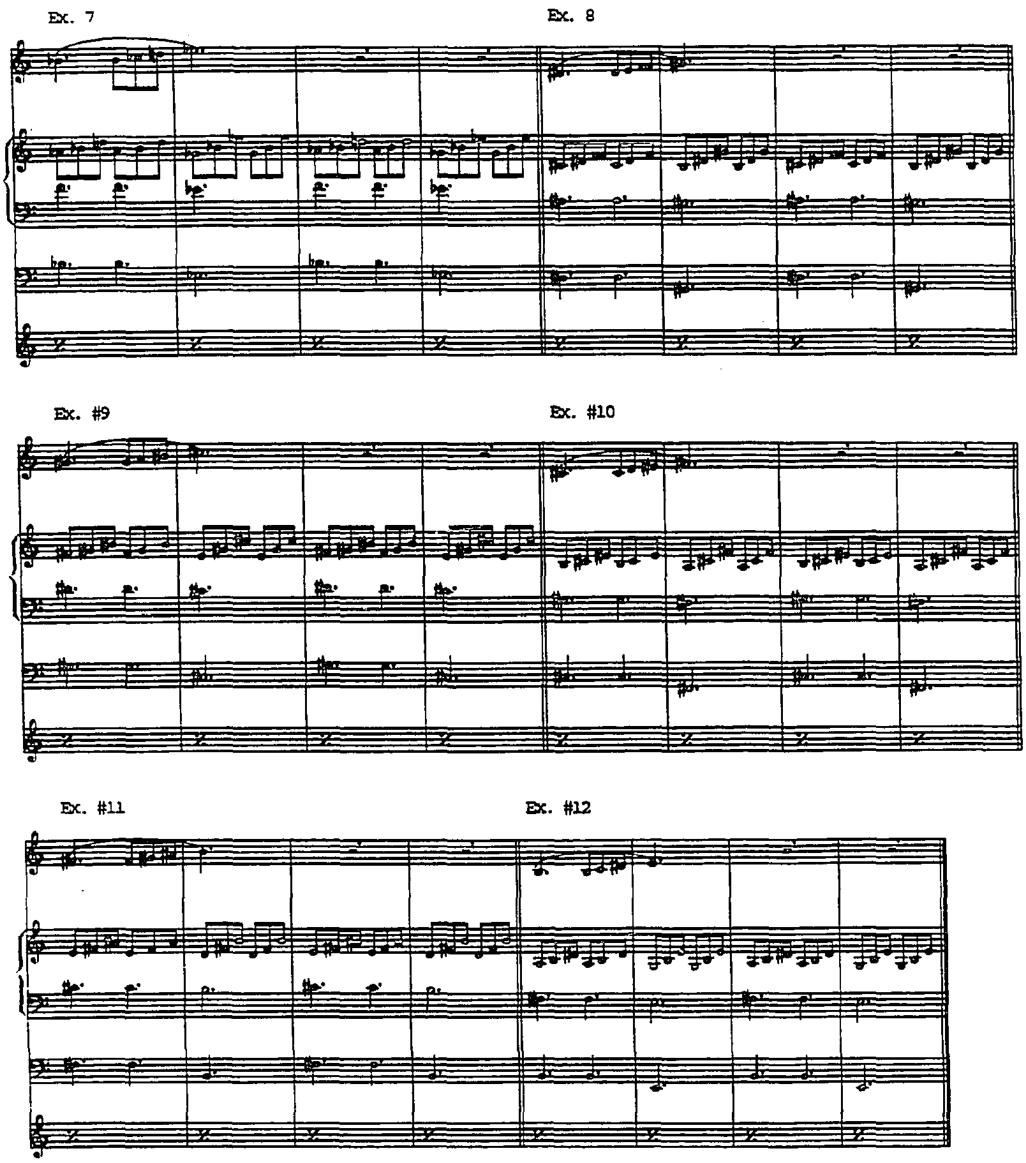

Figure 3.14. (continued)

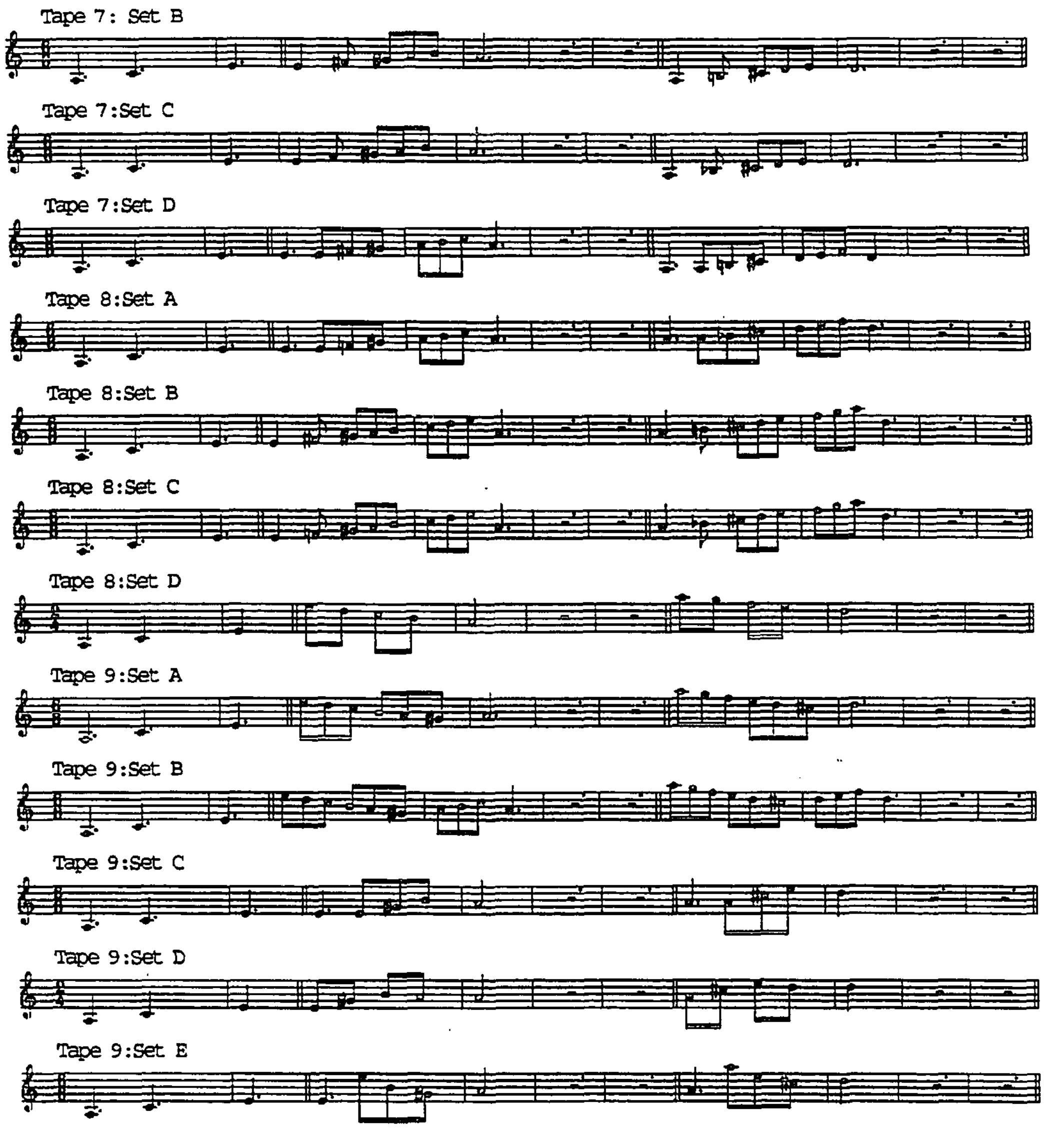

Figure 3.15. Tape 7-9
Melodic Patterns in All Minor Keys Based on I and V^7 Chords
(first two examples in each set)

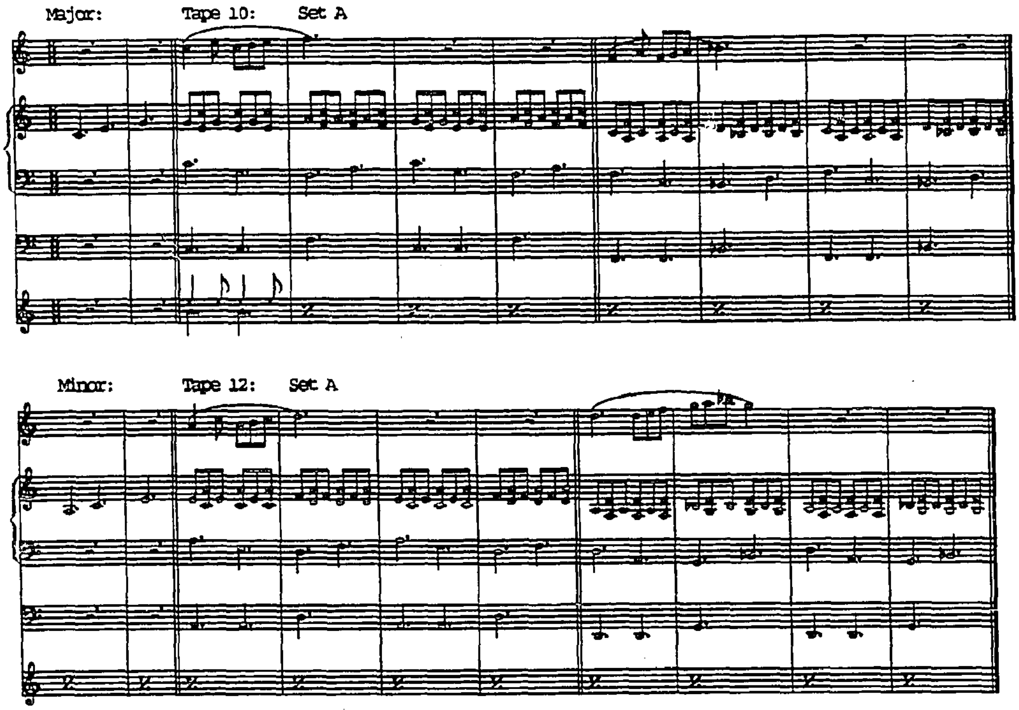

Figure 3.16. Tapes 10-12, Accompaniment Pattern Major and Minor Patterns Based on I and IV Chords

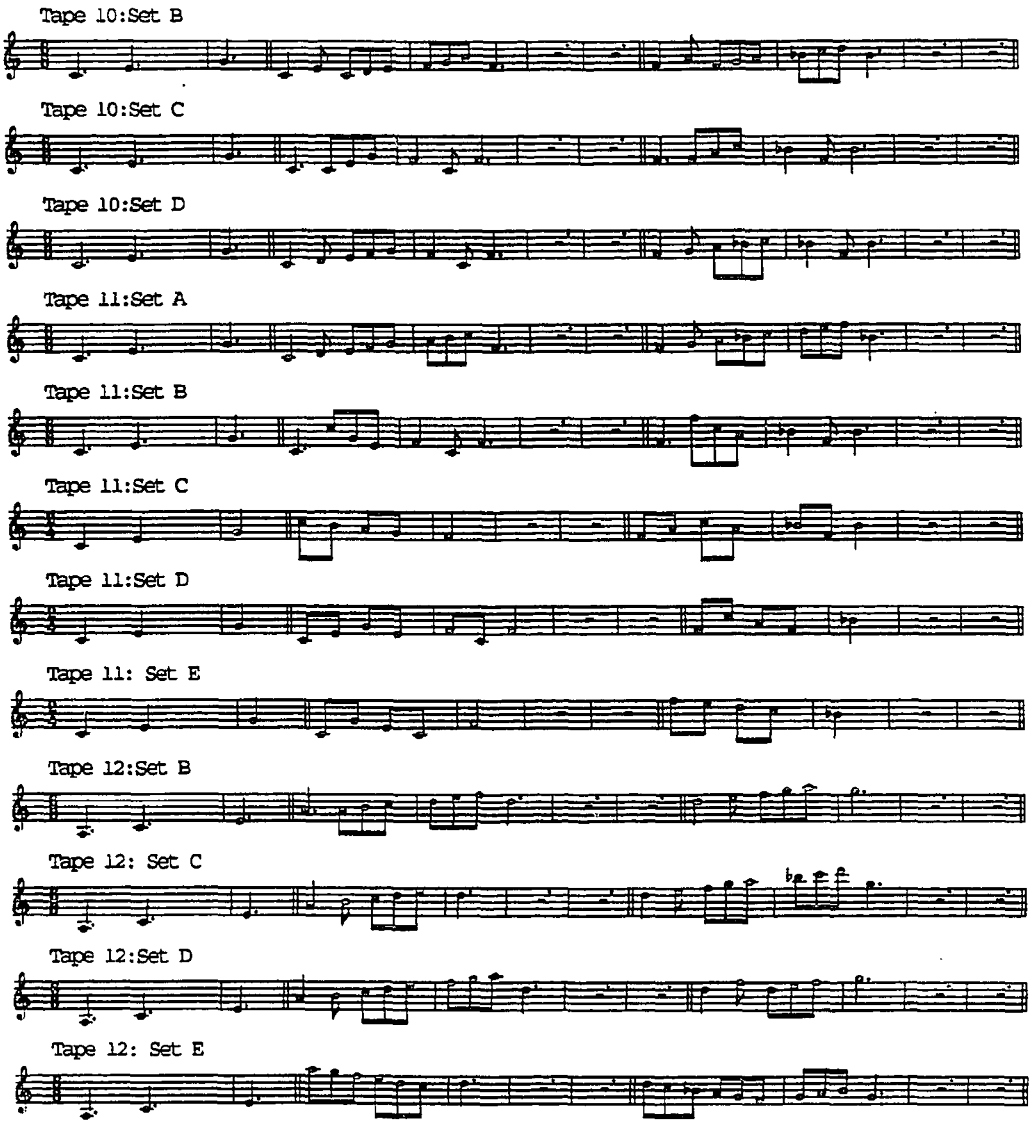

Figure 3.17. Tapes 10-12
Melodic Patterns in All Major and Minor Keys Based on I and IV Chords
(first two examples in each set)

Pretest/Posttest Selection

At the beginning of the treatment, it was necessary to measure each student's level of aural musicianship in order to adjust for ability differences in the memory and performance of melodic patterns. The *Test of Melodic Ear-to-Hand Coordination* (TMEHC) by James O. Froseth, is a criterion-referenced test designed to test the aural discrimination of melodic patterns, which has consistently demonstrated a reliability of .98.[15] It is a 15-minute tape of 100 melodic patterns which are based on tetrachords and are expanded in length and difficulty. Students hear the pattern once and then repeat it by performing the pattern on their principal instrument. This test was chosen because it is designed to measure aural musicianship,[16] and is used as a diagnostic measure to precede Froseth's *MLR Melodic Ear-to Hand Skills Program.*. Success on the test depends upon a musician's ability to accurately discriminate pitches in a melodic pattern and to retain them in the short-term memory in order to be able to repeat the pattern on their major instrument. The students are required to play the patterns on an instrument, as opposed to singing, in order to insure that the students are able to make the association between the aural pitch, the musical symbol and the fingering pattern for this pitch.

At IUP, students are also expected to achieve a score of at least 45% on this test in order to qualify for junior standing as a music education major. Therefore, administering this test to freshman students provided them with an early diagnosis of their skills, and, subsequently, a chance to improve these skills during the period of the experiment. The

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[15]James O. Froseth, *A Longitudinal Study of the Relationship Between Melodic Ear-to-Hand Coordination and Selected Indices of Musical Achievement at the University of Michigan School of Music* (unpublished report to the Executive Committee, School of Music, 1985). Other researchers such as Wilder (1988), Dickey (1991), Humphreys (1986), and Sang (1982) have reported equally high reliability using TMEHC.

[16]Wilder's study (see Wilder, 1988, Chapter 2, p. 33) revealed that melodic ear-to-hand coordination was highly correlated with aural music theory skills as measured by the "Aliferis Music Achievement Test: College Entrance Level (r=.84).

students then were able to apply the posttest scores to their permanent record for use in their junior standing interviews.

There are nine levels of sequences in the melodic ear-to hand test. The test begins with three-note patterns which increase in length to seven pitches. Aural recognition of major, minor, diminished, and augmented triad qualities are all components of the melodic patterns. There is no accompaniment track to assist the student in recognizing the harmonic progressions from which the melodies are derived. Therefore, success on the test, relies on the student's abilities to aurally discriminate each pattern and retain it in the short-term memory long enough to repeat it by performing on the student's major instrument. It can, however, be assumed, according to the hypothesis of this study, that students who score higher on this test have more information available in their long-term memory structures which would enable the chunking mechanism to structure the information rhythmically and/or harmonically into one memory unit.

The major sequences are centered around B^b-major and the minor sequences around G-minor. The practice sequences are only three notes long and are composed of the first, second, third, sixth and seventh scale degrees in B^b-major. Sequence #1 contains patterns which outline the tonic chord in B^b-major or G-minor. Sequence #2 is composed of patterns which use the first five scale degrees of the B^b-major scale, and the patterns are six to seven notes in length. Sequence #3 - Sequence #8 patterns are composed of notes from the various forms of the B^b scale and the various qualities of triads – major, minor, augmented, or diminished – and they increase in length and harmonic complexity.

In conclusion, the *Test of Melodic Ear-to-Hand Coordination* (TMEHC) was chosen as the pre- and posttest measure for this experiment because it is designed to diagnose aural musicianship, and, in addition, the skills that it requires are consistent with the level of aural skills required in the theory skills classes.

Survey Questionnaire

The second hypothesis of this experiment theorizes that the students' ranges of musical background and facility on their instruments may impact their ability to easily chunk patterns and, therefore, to remember and perform them accurately. Therefore, because chunking depends upon familiarity with related memory structures stored in the long-term memory, the students were asked to complete a questionnaire about their musical past (see Figure 3.18). The purpose of this questionnaire was to elicit information about the students' musical background which may have affected the ability to chunk melodic phrases.

Students were asked to list their major and principal instrument of study, as well as information about any private lessons that they had taken. Private piano lessons differ from instruction on other instruments because piano music provides a complete musical background which includes harmonic elements as well as melody and rhythm. That, coupled with learning the basic musicianship skills of reading and fingering necessary to a pianist, seems to make it an ideal instrument for the development of aural musicianship skills. Therefore, students were asked to list separately their years of private piano instruction.

They were also asked to list their years of participation in junior high and high school music ensembles. In this study, junior high and high school was considered grades seven through twelve. It seems quite possible that participation in school music ensembles could be correlated to the scores on the pretest which measures the aural discrimination of

Aural Skills Experiment Survey

Name	
Student #	Phone
Theory Skills Section #	Class Time

1. What is your major? ____________________
2. What is your major instrument?____________________
3. Please list the instrument(s) in which you have had private instruction, the number of years studied, and your age during the instruction (see example below).

Instrument	Years Studied	Age(s)
Ex. Piano	*6*	*6-11*

4. Please list the junior high and high school ensembles in which you participated, the number of years, grade levels, and instrument or voice part (see examples below).

Ensemble	Years	Grades	Instrument/Voice Part
Ex: Women's Chorus	*4*	*9-12*	*2nd Soprano*
Ex: Band	*3*	*7-9*	*Trombone*

4. Please list the high school and previous colleges that you have attended.

High School/College	City, State	Dates of Attendance
Ex. Purchase Line H.S.	*Commodore, PA*	*1985-89*

Thank you for your time and participation!

Pretest________
Posttest________

Figure 3.18. Sample of Survey Questionnaire

melodic patterns. Participation in a music ensemble which includes a melodic, rhythmic, and harmonic background may lead to an improvement in the chunking mechanism which assists music memory and performance. Members of choral and instrumental ensembles not only experience music in a holistic context, but they are also forced to aurally respond in order to play or sing in tune with the rest of the ensemble. Another variable, showing only participation in jazz ensemble, was added to the variable list. The rationale for including this variable lies in the speculation that jazz performers may be involved in improvisation and rely on aural skills, i.e., playing "by ear," more frequently than musicians in other groups. If this is true, it may also be speculated that jazz players' aural skills may be higher than other performers. Because of this, participation in a music ensemble may have a greater impact on the aural musicianship necessary for the memory and performance of melodic patterns than individual instrument study. Therefore students were asked to record the number of years that they participated in any type of musical ensemble during their junior high and high school years.

Lastly, students were asked to list high schools and any other colleges that they may have attended. Also, a blank was added to the survey for both pre- and posttest scores for the convenience of the tester in compiling the background, pre- and postest data for analysis.

Administering the Treatment

The theory classes were assigned to the various groups randomly. Section one was chosen to receive the melody/rhythm/harmony (MRH) treatment – a holistic treatment in which melodic patterns were accompanied by a rhythm and harmony track. Section four received the melody and rhythm treatment (MR). Section two was assigned a treatment with melody only (M). And, lastly, section three served as the control group and received no treatment during class (C) (see Table 3.2 below).

Before beginning the treatment, it was necessary for the students to complete an informed consent form giving permission for the experimental data to be used for research

Table 3.2. Selection of Treatment Groups

Theory Section:	Treatment Group:	Count:	Percent:
#1	MRH	18	30 %
#4	MR	17	28.3 %
#2	M	13	21.7 %
#3	C	12	20 %

purposes (see Figure 3.19). This form gave a brief statement of purpose and a description of the student's involvement. Students were made aware of the fact that their participation was voluntary and could be discontinued at any time without penalty to their grade in the course. The form stated that their participation involved being part of a treatment group which would listen to 10-minute tapes during class time, or part of a control group which would not receive a treatment. Every participant also agreed take a 15-minute pre- and posttest, and complete a survey questionnaire. Benefits of the experiment, as stated on the consent form, were that both the treatment and control groups would benefit from additional ear training practice and /or diagnostic tests which would enhance the student's understanding of his/her aural musicianship. Lastly, the consent form assured the students that their identity would remain confidential, and that their grade for the course would in no way be affected by their involvement in the experiment.

After completing the administration of the pretest, the actual treatment period began during the third week of class and continued for twelve weeks. Students in the three treatment groups spent ten minutes of every class period practicing tape recorded melodic patterns in one of the musical contexts. Students were instructed that they were practicing with the tapes in order to strengthen their ear training skills. Each student's attendance was monitored during the semester. Each treatment group "practiced" the treatment tapes in an electronic piano lab during each of their three class periods a week. Students met at

Informed Consent Form

I understand that the purpose of this research is to gain knowledge and insight about music learning theory in the area of aural training skills. Information for the research study will be gathered by a pre- and posttest which will diagnose my skills in aural musicianship. I will also be asked to complete a survey about my previous musical training. I understand that if I am in a treatment group, I will listen to a 10-minute tape during each class period in the piano lab, and I will play back what I hear. I am aware that the researcher, Susan E. Wheatley, a Ph.D. candidate in Music Education at The University of Michigan, will analyze the accumulated information for significant group achievement differences, and will present her findings in her doctoral dissertation. I know that I may contact her (office phone: 357-7918) at any time with concerns or questions.

As regards my participation in this study, I am aware that:

1. Participation is voluntary and can be discontinued at any time without penalty.

2. Participation involves being part of a treatment group which will listen to 10-minute tapes during class time, and being tested before and after treatment. Testing will be administered during two 15-minute appointments outside of class time;

OR

Participation involves being part of a control group and being tested at the beginning and at the end of the semester. Testing will be administered during two 15-minute appointments outside of class time.

3. Participation also involves an in-class introduction by the researcher, and a survey to be filled out during class time.

4. Both the treatment and control groups will benefit from additional ear-training practice and/or diagnostic tests which will enhance the student's understanding of his/her aural musicianship.

5. Identity of the subjects will remain confidential.

6. Participation in this experiment will in no way affect my grade in this class.

Printed Name:________________________________

Signature:________________________________

Student Number:________________________________

Phone Number:________________________________

Figure 3.19. Sample of Informed Consent Form

individual pianos equipped with ear phones through which the treatment tape was heard. After hearing the pattern, students were supposed to repeat the pattern on their own keyboard. Through the ear phones, students could hear their own piano, but the channels of the other pianos were blocked out in order to avoid interference from the other students. Although the instructor was able to listen in each student's keyboard channel, no attempt was made to give any feedback to the students, or to monitor their progress in any way, except to record each student's participation and attendance.

In the last week of the semester, after twelve weeks of practicing the treatment tapes, the criterion-referenced, *Test of Melodic Ear-to-Hand Coordination* (TMEHC) diagnostic test, was readministered as a posttest measure of the memory and performance of melodic patterns. All sixty of the students who completed the experiment were issued a certificate of achievement showing the progress they had made between the pre- and posttest scores, and these scores were added to the student's permanent record. Many students were able to achieve the level of proficiency required for junior standing as a music education major.

Statistical Methods

After the first four phases were completed – (1) selection of the research sample; (2) preparation of treatment tapes; (3) selection of a diagnostic test for pre- and posttesting; (4) distribution of a student survey questionnaire to analyze background data; and (5) administration of the treatment; – the information was complied into a data set for statistical analysis.

Descriptive statistics were applied to the pretest, program, independent, and outcome variables in order to describe group means and variable ranges. Comparisons among treatment group pretest and posttest scores were made using analysis of variance (ANOVA). Other comparisons among treatment groups and baseline variables were computed using contingency table analysis, t-tests, and ANOVA statistics. Finally, analysis of covariance (ANCOVA) was computed, using multiple regression, in order to adjust for the effects of the pretest and any other background variables which were revealed as significant covariates. After the data had been cleaned of the pretest, the effect of the treatments and/or covariates from students' musical past were analyzed in order to determine whether or not the null hypotheses should be rejected.

CHAPTER IV

STATISTICAL ANALYSIS

This statistical analysis shall be considered in two sections: analysis of background data, and analysis of the treatment effect. The first section gives an analysis of the students' musical past which is interpreted through (1) a description of the pretest score which is an indicator of the students' levels of aural musicianship, or ear-to-hand skills; (2) a description of independent variables gleaned from their questionnaires; and (3) a statistical analysis to discover which of the independent variables can be construed as significant predictors of pretest scores. The implications to be drawn in this section are that background variables may act as covariates along with treatment and pretest in predicting the outcome (ear-to-hand skills). The second section investigates the intervention stage and assesses posttreatment changes among the treatment groups which relate to aural skills. Included in this analysis are: (1) a description of the treatment groups; (2) an analysis of pretest, posttest and change scores among the groups; (3) an analysis of the covariates in terms of their distribution among the treatment groups, and their effect on the outcome (posttest score); and (4) an analysis of covariates as predictors in a multiple regression analysis to determine a predictive model for chunking abilities.

Background Data

A cursory assessment of aural skills is demonstrated in a description of pretest scores. The sixty pretests ranged in scores from 8% to 88%, and the mean score was

35.9% as summarized in Table 4.1. The following histogram, Figure 4.1, shows that the distribution of the scores is skewed and that more scores fell in the lower percentage range.

Table 4.1. Pretest Scores

Mean:	Std. Dev.:	Coef. Var.:	Count:	Minimum:	Maximum:
35.9%	18.4	51	60	8%	88%

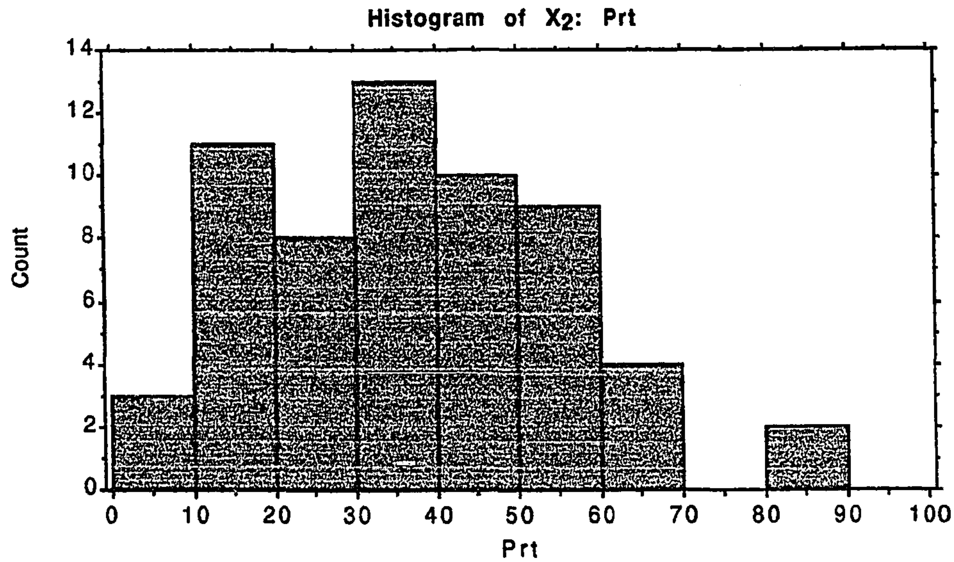

Figure 4.1. Histogram of Pretest Scores

Significant predictors of aural musicianship can also be discovered through an analysis of descriptive data provided by the student questionnaires.[1] Included in the data are a number of independent variables which are listed in the glossary below (Table 4.2), and are subsequently described. A student's choice of major instrument, status concerning private lessons, and participation or not in some school ensembles are found to be significant predictors of pretest scores. Piano lessons, gender, and attendance are not

[1]see Figure 3.18, p. 67.

significant predictors; and the variable, college major, was dropped from the analysis because of its lack of differentiation.

Table 4.2. Glossary of Variables from Questionnaire

Var.Label:	Description:
Attn	Percent of class attendance
ChE	Participation† in school choral ensemble
CIE	Participation in both choral and instrumental ensemble
Fem	Gender
FMI	Major instrument (with fingering patterns)
InE	Participation in school instrumental ensemble
JzE	Participation in school jazz ensemble
Maj	College major
Lsn	Private lessons
Pia	Piano lessons

†participation for at least 1 year in junior high or high school (grades 7-12)

Major Instrument

A five level categorical variable describes the major instrument of the students according to the following instrument types: piano – includes organ majors; voice; percussion – includes all pitched and unpitched mallet instruments; wind – includes all instruments in the brass and woodwind family; and strings – includes all bowed and plucked string instruments such as members of the violin and guitar family.

Table 4.3. Descriptive Statistics for Pretest scores by Major Instrument

Major Instrument:	Count:	Percent:	Pretest Score:	Std. Dev.:
Piano	4	6.7 %	55.5	24.3
Voice	13	21.7%	30.7	16
Percussion	8	13.3%	27	13.8
Wind	32	53.3%	38	17.3
String	3	5.0%	34.3	29.4

Table 4.3 shows that the majority of students studied wind instruments. It was suspected that members of the instrument groups which required finger patterns might score higher on the pretest because of the kinesthetic association required in the memory and performance of melodic patterns. Even though the mean ranged from 27% to 55%, an analysis of variance did not demonstrate that these differences were statistically significant (p=.08). However, since this factor, major instrument, was close to showing significance, it was recoded as a two-level categorical variable which indicated whether the student was studying a major instrument which required finger patterns or not. Table 4.4 summarizes the number of subjects who were recorded as "yes" – wind, string, and piano majors – or "no" – voice or percussion majors – on this new "fingered-major-instrument" variable (FMI).

Table 4.4. Fingered Major Instrument (FMI) Variable and t-test for Pretest Scores

FMI:	Count:	Percent:	Mean:	Std. Dev:	t-test:	P-value:
NO	21	35 %	29.3	15.0	-2.1	.04
YES	39	65%	39.5	19.2		

A unpaired t-test (also Table 4.4) shows a significant result when comparing the FMI factor for pretest scores (p<.05). This analysis supports the research findings that kinesthetic training can impact music achievement (Froseth; Boyle; Baer).[2]

Private Lessons

Table 4.5 summarizes information about the years of private music lessons that each subject had taken prior to attending college. Many students took lessons on a variety of instruments, and the variable reflects a sum of all of these years; this value ranged from

[2]Froseth, 1984, p. 1; Boyle, 1968, pp. 20 & 81; and Baer, 1987.

0 to 31 years. Eight percent (five students) had no experience taking private lessons, while the average number of years was ten. The histogram below (Figure 4.2) gives a profile of the frequency of years studied per student and shows that the most frequent values are from 0 to 18 years. Years of lessons did not correlate significantly with pretest scores. Thus, the

Table 4.5. Years of Lessons

Mean:	Std. Dev:	Minimum:	Maximum:
10.2	6.7	0	31

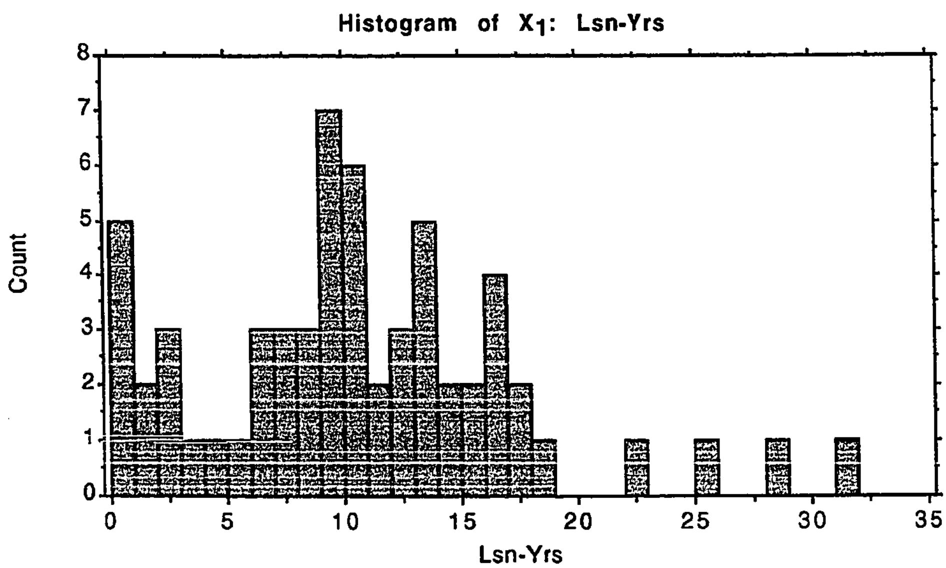

Figure 4.2. Histogram of Years of Lessons

number of years of private lessons does not seem to have a significant effect on aural musicianship as measured by the pretest scores of the sixty subjects.

However, to assess whether the effect of not taking any years of private lessons could produce a different effect on pretest scores, the lessons variable was recoded into a two-level "yes" or "no" variable. When a t-test was computed for this new categorical variable, there was a significant ($p<.05$) difference in mean pretest scores (see Table 4.6).

This result is relatively predictable; it is expected that all college music students would have taken some private lessons on their major instrument (only five students did not take any private lessons), and that these lessons would likely increase their scores.

Table 4.6. Lessons Variable and t-test for Pretest Scores

Lsn:†	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
NO	5	8.3%	18.4	8.8	-2.3	.02*
YES	55	91.7%	37.5	18.2		

†at least 1 yr. of lessons

*Significant at 5%

However, these analyses suggest that beyond rudimentary information about music reading and fingering which is usually mastered in the first year of lessons, the effect of long-term private lessons is not significant to the acquisition of aural skills. One reason for this may be that private lessons on solo instruments do not provide a complete musical context which includes melody, rhythm, and harmony during practice or lesson hours.

Participation in Junior High and High School Ensembles

The students provided information about their participation in a wide variety of high school ensembles on the questionnaire.[3] In order to quantify these data, it was decided that even if a student played in more than one instrumental ensemble during a single year, it was still counted as just one year of experience in instrumental ensembles; likewise for choral ensembles. In this way, a student could participate in a total of six years of instrumental ensembles or six years of choral ensembles in junior and senior high school (grades 7 - 12).

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[3]see Figure 3.18, p. 67.

Student participation was most prevalent in school bands and orchestras as shown in Figure 4.3 (p. 80). Only four students had absolutely no experience playing in an instrumental ensemble. More students played in instrumental ensembles, 93%,[4] than declared strings, winds, or percussion as their major instrument, 72%,[5] indicating that many voice and piano majors also had experience playing secondary instruments. The average number of years was five years, and the mode was six (obtained by 38 students). Participation in jazz ensembles was split about half and half, 29 students were active in jazz ensembles, and 31 had no experience. The average years of involvement among the 60 subjects were 1.6 years as shown in Table 4.7. These descriptive statistics lead to the conclusion that there may indeed be a prominent effect of instrumental music ensembles on ear-training and performance skills.

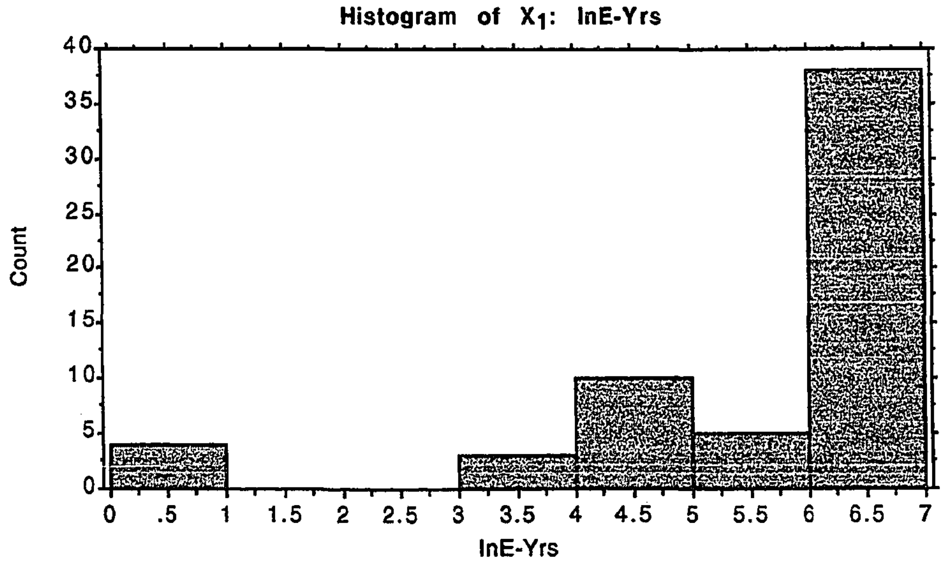
Table 4.7. Years of Participation in School Ensembles

Participation in:	Mean:	Std. Dev.:	Minimum:	Maximum:
Instrumental Ensembles	5	1.6	0	6
Choral Ensembles	2.4	2.5	0	6
Jazz Ensembles	1.6	2	0	6

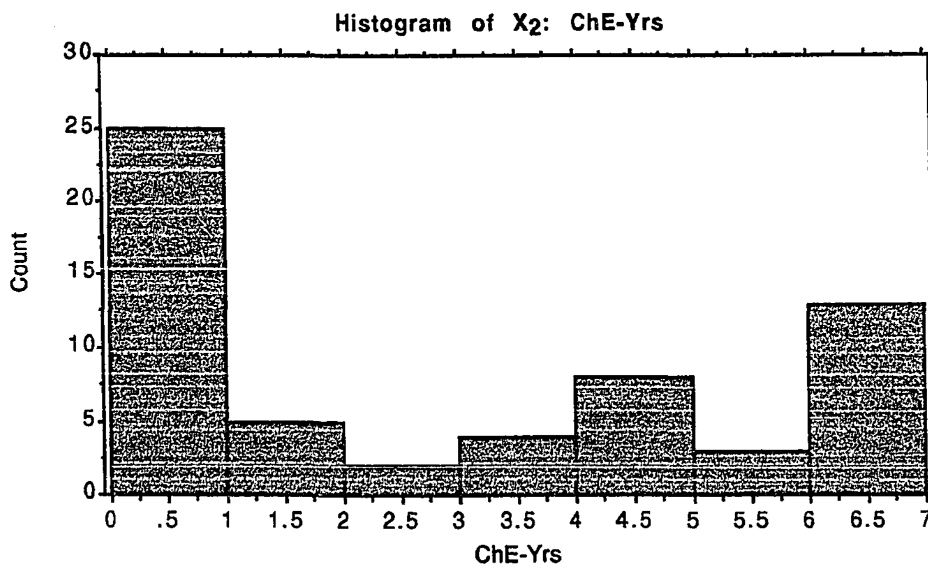
A slightly different pattern of attendance in choral ensembles emerged. The average years of participation were 2.4, but the mode was zero years – 58% participated, 42% did not. The frequency distribution indicated in Figure 4.3, shows that either students chose not to participate, or, if they did, they tended to be involved the maximum number of years. It should be also noted that the percentage of participation, 58%, was twice as high

[4]see Table 4.8, p. 81.

[5]see Table 4.3, p. 75.



Histogram of Participation in Instrumental Ensembles (InE)



Histogram of Participation in Choral Ensembles (ChE)

Figure 4.3. Histograms Showing Participation in School Ensembles

as the percentage of voice majors which is 22%, indicating that a number of non-voice majors also had been members of high school choirs.[6]

Since the purpose of including school music variables in this analysis is to calculate the effect of participation or non-participation in music ensembles on chunking ability as it applies to aural musicianship, these variables were recoded into categories having two values as follows. "Yes" indicates one or more years of participation, and "no" indicates no years of participation for the variables: school instrumental ensembles (InE); school choral ensembles (ChE); and school jazz ensembles (JzE). Each recoded variable was used to compare – "yes" vs. "no" – for the pretest scores by means of an unpaired t-test. Table 4.8 shows that there was a highly significant difference between pretest scores and participation in instrumental ensembles ($p<.01$). However, it also shows that neither choral ensembles or jazz ensembles had a significant effect on pretest scores. These t-tests support the perception gleaned from reviewing the frequencies, that participation in bands and orchestras would be a significant predictor in viewing pretest scores.

Table 4.8. Ensemble Variables – Description and t-tests for Pretest Score

At least 1 yr. of participation in instrumental ensembles (InE), gr. 7-12:

InE:	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
NO	4	6.7%	11	4.1		
YES	56	93.3%	37.7	17.7	-3	.004**

**Significant at 1%

At least 1 yr. of participation in choral ensembles (ChE), gr. 7-12:

ChE:	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
NO	25	41.7%	32.9	19		
YES	35	58.3%	38.1	17.8	-1.1	.28

At least 1 yr. of participation in jazz ensembles (JzE), gr. 7-12:

JzE:	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
NO	31	51.7%	34.4	19.5		
YES	29	48.3%	37.6	17.2	-.67	.57

[6] see Table 4.3, p. 75.

Nevertheless, many instrumental majors also participated in choral activities and vice versa. In keeping with the hypothesis that being exposed to a variety of musical experiences and musical contexts may increase aural musicianship, the question was therefore raised about the effect of having both choral and instrumental participation. As a result, an additional variable was created which indicates participation in both junior high and high school choral and instrumental ensembles (CIE). Fifty-three percent of the students were involved in at least one year of both ensembles, and 47% were not. A comparison of CIE – "yes" vs. "no" – for the pretest score using an unpaired t-test (see Table 4.9), shows that CIE had a significant effect on aural musicianship as measured by the pretest scores.

Table 4.9. Instrumental and Choral Ensemble Variable (CIE) Description and t-test for Pretest Scores

CIE†:	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
NO	28	46.7%	30.6	19.2	-2.9	.03*
YES	32	53.3%	40.7	16.5		

†at least 1 yr. of participation in both choral and instrumental ensembles (InE), gr. 7-12
* Significant at 5%

In summary, there does seem to be an important effect of playing and singing in music ensembles on one's musical skills in terms of the ability to memorize and perform melodic phrases. Playing in an instrumental ensemble has a particularly strong effect. In this study, the pretest, which measures aural skills, requires musicians to associate the melodic sequences with fingering patterns by listening and playing back the sequence. This occurs because the kinesthetic association of the melodic concepts strengthens the chunking mechanism. It could, therefore, be assumed that instrumental music experiences would be of the greatest benefit as is shown by one's participation in bands and orchestras. Perhaps an equally important finding in analyzing these descriptive statistics is that both participation in choral and instrumental activities as measured by the CIE variable have a significant effect on the development of one's skills in the memory and performance of melodic patterns.

Private Piano Lessons

Although, the number of years of private piano lessons in the sample ranged from zero to 15 years, one can see in Figure 4.4 that the majority of students (35) had no piano lessons. However, the remaining 25 students averaged 5.3 years of piano lessons.

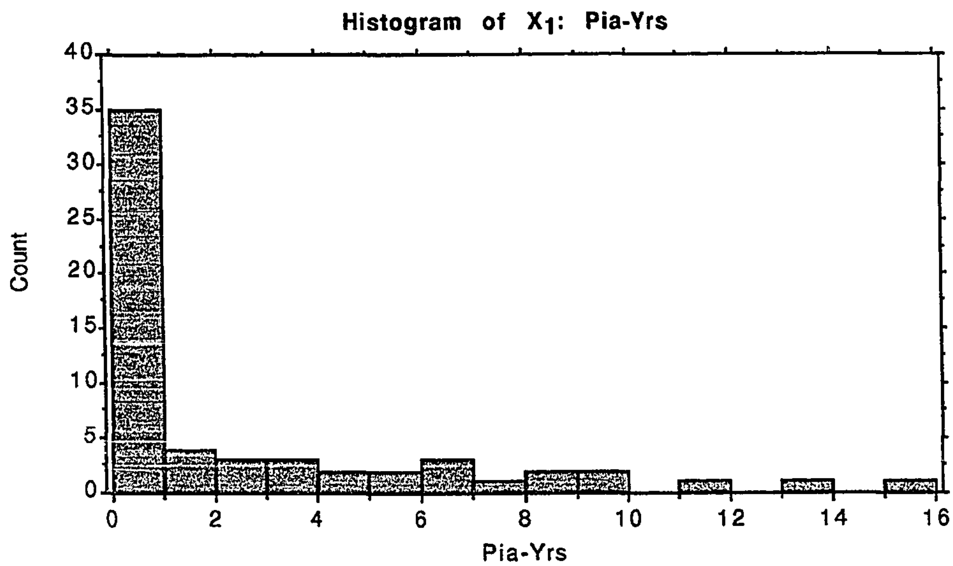


Figure 4.4. Histogram of Years of Piano Lessons

Therefore, the piano variable was recoded into a two-level categorical variable which recorded whether or not the students had at least one year of private piano lessons. Fifty-eight percent of the subjects had less than one year of private piano instruction; 48% had one or more years of instruction. However, the unpaired t-test using this categorical piano variable does not indicate a significant difference in the pretest scores as a measure of aural musicianship as seen in the t-test (p=.11), Table 4.10. Thus, while there seems to be some effect of taking private piano lessons, this effect is not a significant predictor of aural musicianship as measured by the students' pretest scores.

Table 4.10. Piano Variable (Pia)
Description and t-test for Pretest Scores

Pia†:	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
NO	35	58.3%	32.7	18.3		
YES	25	41.7%	40.4	17.8	-1.6	.11

†at least 1 yr. of private piano lessons

Gender

A categorical variable for the gender of each subject was coded to determine if there is any effect of gender on pretest scores. The sample was almost divided evenly between males (52%) and females (48%). There was no effect of gender on pretest scores as indicated by the t-test in Table 4.11:

Table 4.11. Gender Variable (Fem)
Description and t-test for Pretest Scores

Gender:	Count:	Percent:	Pretest:	Std. Dev.:	t-test:	P-value:
MALE	31	51.7%	34.5	21.8		
FEM.	29	48.3%	37.5	14.1	-.68	.53

Attendance

Table 4.12 shows that the attendance scores for the students ranged from 44% to 100%, with a mean of 74% and a standard deviation of 16%. This attendance pattern is negatively skewed (see Figure 4.5), indicating that there is a greater frequency of percentages in the higher range. Twenty percent of the students recorded the mode percentage of attendance which was 88%, while 33% of the population had 88% or higher attendance. The correlation between attendance and the pretest score was 0.05 which indicated no association between attendance and pretest score (p=.70).

Table 4.12. Attendance

Mean:	Std. Dev.:	Count:	Minimum:	Maximum:
74.1	16	60	44	100

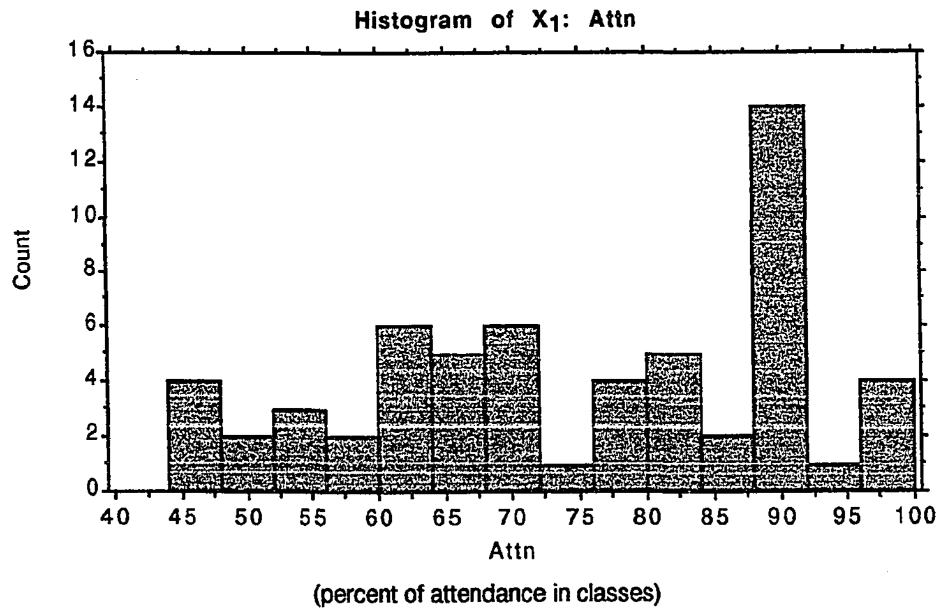


Figure 4.5. Histogram Showing Attendance Patterns

Major

Since Indiana University of Pennsylvania is formerly a teacher's college, and still places a heavy emphasis on teacher training, there were too few majors outside of music education to separate this factor for analysis. In this sample, 77% of the subjects were music education majors. Only about 6% were enrolled in other music programs: two were composition majors, and two were performance (applied) majors as shown in Table 4.13.

A larger percentage – 17% – were either undecided about their major, were music minors or were enrolled in a general Bachelor of Arts major. It was speculated that the musical background of this latter group may have differed from the other 83%. As shown in Table 4.13, an analysis of variance comparing the pretest scores across the four groups by major (music education, composition, applied music, and non-music) shows that there is a significant difference between the groups (p=.03).

Table 4.13. Description of Students' Major and Analysis of Variance of Pretest Scores by Major

Major:	Count:	Percent:	Pretest Score:
Music Education	46	76.7	35%
Composition	2	3.3	71%
Applied Music	2	3.3	47.5%
Non-music	10	16.7	30.9%

One Factor Analysis of Variance

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	3	3018	1006	3.3
Within groups	56	16848	301	p=.03*
Total	59	19867		

*Significant at 5%

Comparison:	Mean Difference:	Scheffé F-test:
Mus Ed. vs. Comp.	-36	2.7
Mus Ed. vs. Applied	-12.5	0.3
Mus Ed. vs. Non-music	4.1	0.16
Comp. vs. Applied	23.5	0.6
Comp. vs. Non-music	40.1	3.0 *

* Significant at 5%

However, subsequent pairwise multiple comparisons showed no significant difference between the pretest scores of those in the non-music majors group compared with the music education majors. The only significant pair was between composition majors and non-music majors. This effect results from the high pretest scores (mean value of 71%) of the two composition majors which could be predicted, since talent for composing music necessarily requires a greater aptitude for aural music skills. Composers must be able to internalize sounds before performing or writing them down in musical notation. This premise, and the fact that there were too few majors outside of music education, led to the decision not to include "major" as an independent variable in any further statistical analysis.

Summary

These analyses reveal, first, that several of the independent baseline variables had a significant effect in determining the beginning level of aural musicianship as measured by pretest scores. Those background variables include the major instrument, school ensembles, and private lessons. Significant increases in pretest scores were noted in those cases where a student studied a major instrument with fingering patterns (FMI), participated in band or orchestra (InE), and was a member of both instrumental and choral ensembles (CIE). In terms of private lessons (Lsn), differences were apparent in a comparison between those students who had no private lessons at all and students who had one or more years of lessons. In summary, because these variables are significantly related to pretest score, they may also show a correlation to posttest scores, and, thus, may be considered as covariates in analyses assessing the treatment effect as discussed in the next section.

Intervention Stage

During the intervention stage, students were assigned to four groups. Table 4.14 shows that the mean pretest scores for the individual groups vary from 22% to 57%. A statistical analysis of these scores by using the analysis of variance reveals that there are significant differences between pretest scores among the treatment groups. The P-value

Table 4.14. Pretest Score Analysis

Group:	Count:	Mean:	Std. Dev.:	Minimum:	Maximum:
Overall	60	35.9	18.4	8	88
MRH	18	22.5	14.5	8	51
MR	17	29.8	10.5	10	53
M	13	43	6.2	31	53
C	12	57.2	19.4	20	88

(i.e., the probability that this difference would occur at random) is given in Table 4.15, and is less than one hundredth of a percent ($p<.0001$). The table further shows that the differences that are most significant (by Scheffé's method, $p < 0.05$) are between the MRH (melody, rhythm, harmony) and M (melody) group; MRH and C (control) group; and MR (melody and rhythm) and the C group. Based on this statistical analysis, these groups do

Table 4.15. Analysis of Variance of Pretest Scores by Program

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	3	9942	3314	18.7
Within groups	56	9925	177	p=.0001
Total	59	19867		

Comparison:	Mean Difference:	Scheffé F-test:
MRH vs. MR	-7.3	0.9
MRH vs. M	-20.5	6.0 *
MRH vs. C	34.7	16.3 *
MR vs. M	-13.2	2.4
MR vs. C	-27.3	9.9 *
M vs. C	-14.2	2.4

* Significant at 5%

not appear to have been randomly selected, even though students were assumed to enroll randomly in the theory skills sections. A possible reason why this happened could be because the basic theory courses which are elected concurrently with the theory skills sections are tracked groups according to students' aural discrimination abilities. This could have affected the enrollment pattern of the theory skills sections because it was discovered that, in some cases, the theory skills and basic theory classes were scheduled at the same time, thus limiting the possibility of randomness in the students' enrollment choices of theory skills sections. Thus, in analyses of the posttest scores, adjustment of the pretest, using the analysis of covariance, will be effected.

The pattern of the posttest scores among the four groups was similar to the pretest. Table 4.16 shows that the minimum posttest score over all students was 12% and the

Table 4.16. Posttest Score Analysis

Group:	Count:	Mean:	Std. Dev.:	Minimum:	Maximum:
Overall	60	47.6	19	12	95
MRH	18	34.4	15	12	60
MR	17	43.4	16.9	15	69
M	13	52.7	8.4	36	68
C	12	67.6	17.7	40	95

maximum was 95%, thus, producing a range of 83 percentage points. This range differed only slightly with the range of the pretest scores which was 80 percentage points, where the high and low scores were 88% and 8% respectively.[7] Table 4.17 shows that the correlation between pre- and posttest scores is very high (r=0.87). As expected, when the

Table 4.17. Correlation between Pretest and Posttest

Number of Cases:	Correlation:	Probability:
60	.87	.000***

***Significant at .1%

pretest scores are high, the posttest scores are also high. The regression illustrated in Figure 4.6, shows this high positive correlation of the scores. Furthermore, as was true in the pretest scores, one can see by Table 4.18, that the posttest scores demonstrate significant differences among the treatment groups when tested by the analysis of variance (p<.0001). Because the posttest scores were so highly correlated to the pretest scores among the groups, it is likely that they do not represent a true picture of the treatment

[7]see Table 4.14, p. 88.

effects. Therefore, in order to clarify the effect of the intervention stage, it was necessary to measure the change in scores among the four groups.

Table 4.18. One Factor Analysis of Variance of Posttest Scores by Program

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	3	8561	2854	12.6
Within groups	56	12676	177	p=.0001
Total	59	21237		

Comparison:	Mean Difference:	Scheffé F-test:
MRH vs. MR	- 8.9	1
MRH vs. M	-18.3	3.7 *
MRH vs. C	-33.1	11.6 *
MR vs. M	-9.4	1
MR vs. C	-24.2	6.1 *
M vs. C	-14.8	2

* Significant at 5%

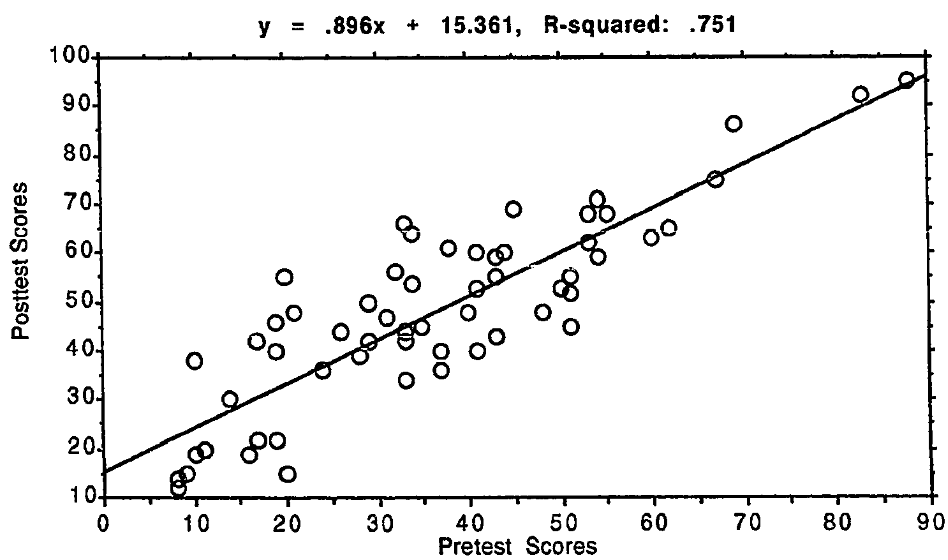


Figure 4.6. Regression of Posttest Scores on Pretest Scores

A variable to describe the changes in scores which occurred after the treatment, was computed by subtracting the pretest score from the posttest score for each student (see Table 4.19). This variable, which points out the change scores among the treatment groups, shows that the average change was 12%. Two students fell one percentage point lower on the posttest than the pretest, while the largest gain was 35%. Twenty-six percent of the students gained between five and ten percentage points, and the most frequently reported change score was 8% (see Figure 4.7).

Table 4.19. Change Score Analysis

Group:	Count:	Mean:	Std. Dev.:	Minimum:	Maximum:
Overall	60	12	9.2	-1	35
MRH	18	12.7	9.3	1	30
MR	17	14.1	10.1	1	33
M	13	9.8	8.0	-1	23
C	12	10.4	9.5	-1	35

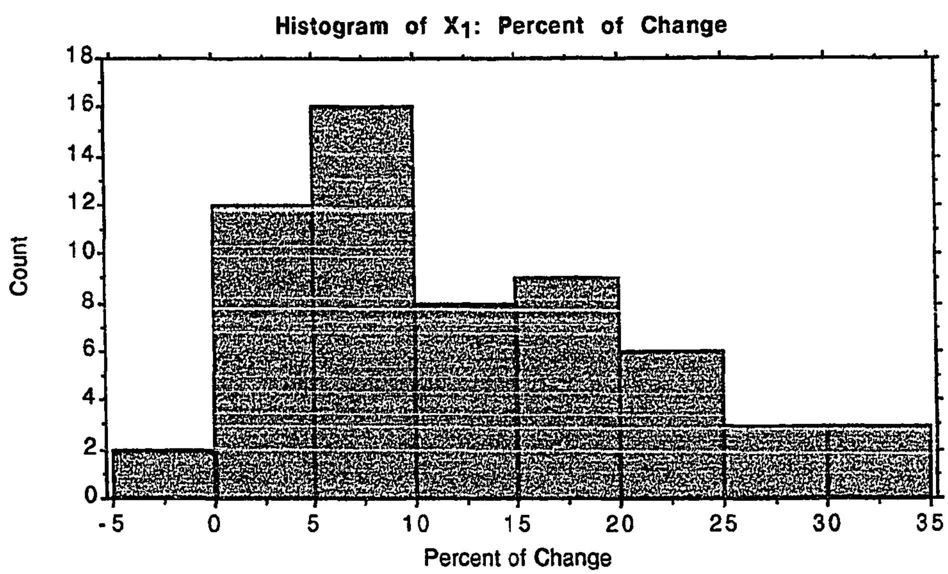


Figure 4.7. Histogram of Change Scores

The possible causes of change could include, among other factors, the effect of the various treatments, the effect of the student's musical background, or the effect of the student's beginning level of aural musicianship (i.e., pretest). It is notable that the students who began with low pretest scores tended to have the lowest posttest scores, and that the students who had higher pretest scores also finished with higher posttest scores. Treatment group MR (melody and rhythm), shows the most gain at 14.1 percentage points, and MRH (melody, rhythm, and harmony) has the next highest gain of 12.7. The control group achieved a mean 10.4% increase, and M (melody only) has the lowest gain of 9.8% (see Figure 4.8). Although generally, the treatment groups achieved more gain, they also started lower and had more room to grow. Furthermore, there was no significant

Table 4.20. Analysis of Variance of Change Scores by Program

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	3	176	59	.675
Within groups	56	4866	87	p=.571
Total	59	5042		

Comparison:	Mean Difference:	Scheffé F-test:
MRH vs. MR	-1.4	0.07
MRH vs. M	-2.9	0.2
MRH vs. C	2.3	0.2
MR vs. M	4.3	0.5
MR vs. C	3.7	0.4
M vs. C	-0.6	0.0

* Significant at 5%

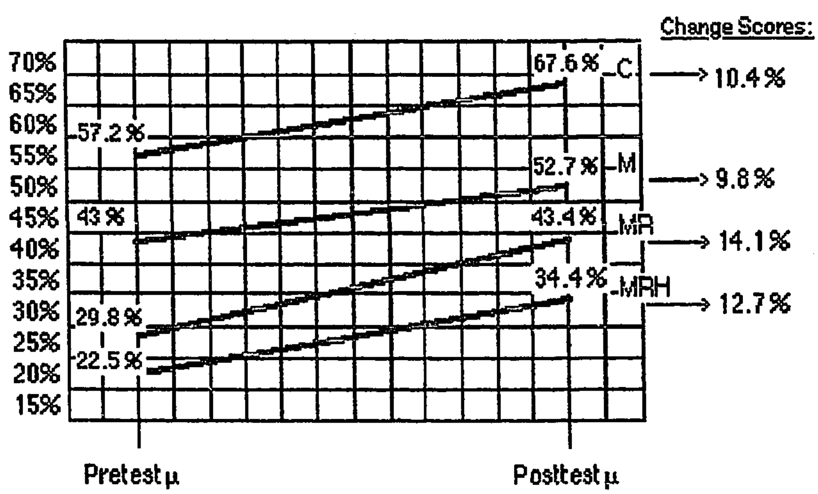


Figure 4.8. Graph of Change Scores by Groups

difference between any of the change scores when the program and change variables were analyzed by means of analysis of variance. In conclusion, with respect to the effect of the treatments, the four groups (MRH, MR, M, and C) had significantly different scores on both the pre- and posttests, but there was no difference among groups found in the change scores.

While change scores represent an analytic technique to assess whether the differences among treatments for post scores could be attributable to pre-existing conditions (e.g., pretest scores), a more sensitive statistical analytic technique is the analysis of covariance (ANCOVA). ANCOVA is a method of analysis of treatment effects for groups that are non-equivalent for conditions which predate the treatments. The technique adjusts for the effects of confounding variables. Two features which indicate the presence of confounding variables are: (1) the groups differ significantly on the variable before treatment; and (2) this variable is significantly related to the outcome. This study meets both of these criteria: the treatment groups differ on the pretest variable, and the pretest is significantly related to the outcome. In addition, the major instrument variable (FMI), and the categorical variables describing participation in instrumental ensembles (InE), participation in both choral and instrumental ensembles (CIE), and experience taking private lessons (Lsn) are significantly related to the pretest.

The next step in the analysis of covariance, is to determine if these variables differ significantly among the treatment groups. Therefore, the categorical variables were compared by contingency table analysis, and the continuous variables by analysis of variance among the treatment groups.[8] Table 4.21 summarizes the relationships between treatment variables, independent variables, and outcome variables below:

[8]these analyses are presented in Tables 4.30-4.42, found in Appendix A, pp. 139-144.

Table 4.21. Variables Glossary – Summary of Associations from Chi-Square Analysis and ANOVA

Treatment Variables

Label	Description	Sig. relationships with other independent var.
MRH	Melody,rhythm,&harmony trt.grp.	CIE, InE, Lsn, Pia
MR	Melody with rhythm trt. grp.	
M	Melody only treatmt. group	ChE, CIE
C	Control group – no treatment	

Independent Variables

Label	Description	Sig. relationships with other independent var.
Attn	% of class attendance	ChE, CIE
ChE	Partic*. in choral ensembles M	Attn,CIE,Fem
CIE	Partic. in both choral & instr.ens.	MRH, M,Attn,ChE,InE
Fem	Gender	ChE
FMI	Fingered major instrument	
InE	Partic. in instrumental ensembles	MRH CIE, JzE
JzE	Partic. in jazz ensembles	InE
Lsn	1 yr. or more private lessons	MRH, Pia
Pia	1 yr. or more piano lessons	MRH, Lsn

*at least one year participation in high school ensembles

Dependent Variables

Label	Description	Sig. relationships with treatment or other var.
Prt	Pretest scores	MRH, C, CIE, FMI, InE, Lsn, Pst
Pst	Posttest scores	MRH, C, CIE, InE, Prt

The MRH group (melody, rhythm, harmony) showed the most differences before treatment.[9] This group, which had the lowest pretest score, also had the most students that had no piano lessons (Pia), no private lessons of any kind (Lsn), no involvement in band or orchestra (InE), and had the least number of students who were involved in both choral and instrumental ensembles (CIE). Only five students in the entire sample took no private lessons, and four were in group MRH (melody, rhythm, harmony). Overall, 58% (35 out of 60) of the subjects had no piano lessons, but in group MRH, 78% (14 out of 18) had no piano. Four out of a total of 60 cases had no involvement in band or orchestra, and all of

[9]see Tables 4.30-4.32, pp. 139-140.

these were in the MRH group. Lastly, better than half of the subjects (32 out of 60) in the total group said "yes" to CIE (participation in both choral and instrumental ensembles), whereas only one-third of MRH group members (6 out of 18) had the same involvement. These background deficiencies set this group apart significantly on both the pre- and posttest scores. By random selection, they received the most holistic music treatment, and consequently, they did gain more than the melody only (M) and control groups (C) – an average of 12.7 percentage points between tests. However, even with the help of the treatment, it may be argued that no amount of practice could help the MRH group to attain the same proficiency in aural musicianship as students in the other groups.

Table 4.22. Contingency Table Analysis – MRH with Categorical Variables

		MRH		Other			
		No	Yes	No	Yes	X^2 Stat.	P-Value
Pia	1 yr. or more private piano	14	4	21	21	4	.04*
Lsn	1 yr. or more private lessons	4	14	1	41	6.5	.01*
InE	Partic. in Instrumental Ensembles	4	14	0	42	10	.001**
CIE	Partic. in both choral & instr. ens.	12	6	16	26	4.1	.04*

* Significant at 5% **Significant at 1%

Group M (melody only) differed significantly on the CIE (participation in both choral and instrumental ensembles) and the ChE (participation in choral ensembles) variables.[10] The M group had a much higher number of students that were involved in choral ensembles and in both types of ensembles. Eleven out of 13, or 85% of the M group had CIE experience as opposed to 53% of the total (N=60). Those same eleven students (85% of M) compared with 58% of the total population on choral ensemble (ChE) participation. This important experience of singing in a group ensemble as well as playing an instrument seems to be substantiated by the M-group's relatively high pretest score mean of 43% as compared to the total group average of 35%. On the other hand, it is also

[10]see Tables 4.34 and 4.35, p. 141.

notable that their gain of 9.8 percentage points was not as high as the gains in the other treatment groups. This could be because the M treatment is set in the least complete musical context, with no rhythm or harmony track added to the taped exercises.

Table 4.23. Contingency Table Analysis – M with Categorical Variables

		MRH		Other			
		No	Yes	No	Yes	X^2 Stat.	P-Value
CIE	Partic. in both choral & instr. ens.	2	11	26	21	6.5	.03*
ChE	Partic. in choral ensembles	2	11	23	24	4.7	.03*

* Significant at 5%

Group MR (melody and rhythm) showed no differences before treatment on any variables including the pretest. The control group also did not show a marked difference on the background variables before treatment, but, this group's pretest score mean of 57% was the highest.[11] The effect of this very high score mean seems to have drained away the effect of any other background differences, and therefore one can predict that neither treatment nor lack of treatment would have an effect on this group's scores. It is, in fact, noted that although they were the control group, their higher posttest score mean (68%) did indicate a high significance of difference when compared to other groups. None of the groups varied significantly on the major instrument (FMI) variable, and neither is the FMI variable correlated to the posttest.

Some of the significant correlations between the categorical variables themselves were not so revealing (see summary in Table 4.21). For example, it should be expected that piano lessons and private lessons are highly correlated because years of piano is also included in the lessons variable.[12] This is also true of the jazz (JzE) and instrumental

[11]see Table 4.14, p. 88.

[12]see Table 4.36, p. 142.

ensemble (InE) variables, and of the CIE variable and its significant relationship to the InE and ChE variables.[13] However, there was no evidence by chi square analysis that the instrumental variable (InE) and the choral variable (ChE) were significantly correlated, and, therefore, the CIE variable (participation in both choral and instrumental ensembles) can be considered useful as a separate predictor along with participation in only instrumental or only choral ensembles.

Other interesting associations were revealed in this analysis about the effect of background variables on class attendance. The students that showed the most involvement in choral ensembles and both ensembles tended to have a better attendance record in class.[14] This pattern may indicate that these students, whose musical backgrounds show that they have chosen to be very active in a number of group ensembles, are more highly motivated to learn skills in a group situation as opposed to individual study. It may also indicate that they are more self-disciplined in attending class because regular attendance in music ensembles is a high priority. And lastly, Chi-square analysis, reveals that a higher percentage of females are active in choral ensembles than males.[15]

The purpose of analyzing the contingency tables and ANOVA statistics was to determine the presence of confounding variables, that is, variables in which the groups differ significantly before the treatment, and are also significantly related to the outcome. The analyses show that private lessons (Lsn), piano lessons (Pia), participation in instrumental ensembles (InE), choral ensembles (ChE), and both types of ensembles (CIE) are related to both program and outcome. Moreover, in this data set, the control group outperformed the other groups on both the pre- and posttest. Therefore, it is confirmed that analysis of covariance, which can adjust for the effects of these confounding variables as

[13]see Tables 4.37-4.39, pp. 142-143.

[14]see Tables 4.41 and 4.42, p. 144.

[15]see Tables 4.40, p. 144.

well as the pretest, is the appropriate statistical analysis to accurately measure treatment effect. Multiple regression, a generalization of the ANCOVA, is admirably suited to the analysis of mixed data – data in which one or more variables have been manipulated, and also in which there are many attribute variables.[16] ANCOVA adjusts for covariates in a regression model by a matching procedure whereby for any given pretest value, it takes the predicted posttest values for the significant difference then, "suggests" that one group would have significantly outperformed the other on the posttest if the groups had started with the same pretest scores and the same background conditions.[17]

In the first of these general analyses, all covariate variables were entered into a regression model as shown in Table 4.24. Significant predictor variables were the pretest, as expected ($p<.0001$), and, in addition, participation in instrumental ensembles (InE) ($p=.027$) and in both ensembles (CIE) ($p=.038$). The choral ensemble variable (ChE) was close to showing significance at $p=.078$. Overall, seventy-five percent of the variance of the posttest scores is accounted for in this model, which means that the residual, or unexplained, variance is about 25% (i.e., related to other factors not included in the model). The three treatment indicators did not have coefficients which would yield a significant effect in the regression model. It is notable that participation in high school ensembles could have a greater impact on predicting aural musicianship than private lessons on any instrument, including the piano. This finding is considered consistent with the hypothesis that aural musicianship is developed best when students are exposed to a holistic musical environment, and can, therefore, call upon chunking as a mechanism for the memory and performance of melodic phrases.

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[16]Multiple regression analysis yields a variance coefficient, R 2 , which expresses the amount of variance of Y, the dependent variable (posttest), accounted for by the regression combination of all the X s, the independent variables (pretest and other significant independent variables). The residual variance is that portion that is not accounted for by the X s. Multiple regression is admirably suited to the analysis of mixed data, data in which one or more variables have been manipulated, and also in which there are many attribute variables.

[17]Thomas Cook and Donald Campbell, *Quasi-Experimentation* (Boston: Houghton Mifflin, 1979), p. 155.

Table 4.24. ANCOVA, Model 1
Multiple Regression Y: Posttest 13 X variables

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.81	.75	9.44

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	13	17139	1318	14.8
RESIDUAL	46	4097	89	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	36.6			
Prt	Pretest scores	.94	.11	8.51	.0001**
MRH	Melody,rhythm,&harmony trt.grp.	-2.67	4.98	.56	.59
MR	Melody with rhythm trt. grp.	1.79	4.69	.38	.70
M	Melody only treatmt. group	-2.01	4.19	.50	.62
InE	Partic.† in instrumental ens.	-24.1	10.56	2.29	.03 *
FMI	Fingered major instrument	-4.8	3.26	1.47	.15
CIE	Partic. in both choral & instr.ens	-6.69	5.84	1.15	.26
Lsn	1 yr. or more private lessons	-4.83	5.26	.92	.36
Pia	1 yr. or more piano lessons	1.65	2.77	.60	.55
ChE	Partic. in choral ensembles	-21.02	11.68	1.8	.08
JzE	Partic. in jazz ensembles	2.45	2.7	1.9	.37
Fem	Gender	-.3	2.72	.11	.91
Attn	% of class attendance	.09	.091	.05	.30

† at least one year participation in high school ensembles

In an effort to achieve a more parsimonious regression model, the next ANCOVA included only the pretest, program variables, and those additional variables – private lessons (Lsn), piano lessons (Pia), participation in instrumental ensembles (InE), choral ensembles (ChE), and both ensembles (CIE) – which were demonstrated to be related to both program and outcome. According to Hinkle, prediction is typically enhanced very little by using more than five or six predictors. And, in general, it is better to select predictors that correlate highly with the outcome or criterion variable, but that have low correlations among themselves.[18] This second model (Table 4.25) has six variables plus

[18]Dennis Hinkle, William Wiersma, and Stephen Jurs, *Applied Statistics for the Behavioral Sciences* (Hopewell, NJ: Houghton Mifflin, 1979), p. 413.

Table 4.25. ANCOVA, Model 2
Multiple Regression Y: Posttest 9 X variables

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.79	.75	9.42

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	9	16799	1866	21.03
RESIDUAL	50	4438	89	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	36.72			
Prt	Pretest scores	.89	.10	8.80	.000***
MRH	Melody,rhythm,&harmony trt.grp.	-2.82	4.93	.57	.57
MR	Melody with rhythm trt. grp.	1.33	4.49	.30	.77
M	Melody only treatmt. group	-3.2	4.10	.78	.44
InE	Partic.† in instrumental ens.	-19.6	10.07	1.94	.06
CIE	Partic. in both choral & instr.ens	21.41	11.28	1.90	.06
Lsn	1 yr. or more private lessons	-4.83	5.26	.92	.36
Pia	1 yr. or more piano lessons	1.10	2.61	.42	.68
ChE	Partic. in choral ensembles	-15.89	10.91	1.5	.15

† at least one year participation in high school ensembles

***Significant at .1%

the three treatment indicator variables. It is more parsimonious, but unfortunately, none of the variables show significance except the pretest. The variables, participation in instrumental ensembles (InE), and in both ensembles (CIE), however, were close with p-values of .06. At this point a decision was made to remove the piano variable (Pia) because of its large p-value (.67) and, also, its correlation to private lessons (Lsn), as it is not desirable for two independent variables to be highly correlated in a regression model (Table 4.26). This step did not improve the significance of the private lessons variable (Lsn), and

Table 4.26. ANCOVA, Model 3:
Multiple Regression Y: Posttest 8 X variables

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.79	.75	9.35

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	8	16783	2098	24.02
RESIDUAL	51	4454	83	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	36.45			
Prt	Pretest scores	.90	.10	8.93	.000***
MRH	Melody,rhythm,&harmony trt.grp.	-2.94	4.89	.60	.55
MR	Melody with rhythm trt. grp.	1.41	4.45	.32	.75
M	Melody only treatmt. group	-3.11	4.06	.77	.45
InE	Partic.† in instrumental ens.	-19.29	9.97	1.93	.06
CIE	Partic. in both choral & instr.ens	21.05	11.16	1.94	.06
Lsn	1 yr. or more private lessons	-4.48	5.15	.87	.39
ChE	Partic. in choral ensembles	-15.53	10.79	1.44	.16

† at least one year participation in high school ensembles

***Significant at .1%

the participation variables (InE and CIE) were still only "close" to significance. Next, private lessons (Lsn) (p=.38), and finally the choral participation variable (ChE) (p=.156) were deleted from the model (Tables 4.27 and 4.28). Now participation in both choral and instrumental ensembles (CIE) becomes significant at .03, and participation in instrumental ensembles (InE) loses significance to p=.27 (Table 4.28). As it was expected that the correlation between the variables, instrumental ensemble participation (InE), and participation in both ensembles (CIE), had too much shared variance in the model, InE

Table 4.27. ANCOVA, Model 4:
Multiple Regression Y: Posttest 7 X variables

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.79	.76	9.32

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	7	16717	2388	27.47
RESIDUAL	52	4520	87	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	31.40			
Prt	Pretest scores	.88	.10	9.01	.000***
MRH	Melody,rhythm,&harmony trt.grp.	-2.15	4.79	.45	.66
MR	Melody with rhythm trt. grp.	1.28	4.43	.29	.77
M	Melody only treatmt. group	-3.55	4.02	.88	.38
InE	Partic.† in instrumental ens.	-17.99	9.831	.83	.07
CIE	Partic. in both choral & instr.ens	21.76	11.10	1.96	.06
ChE	Partic. in choral ensembles	-15.50	10.77	1.44	.16

† at least one year participation in high school ensembles

***Significant at .1%

Table 4.28. ANCOVA, Model 5:
Multiple Regression Y: Posttest 6 X variables

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.78	.75	9.41

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	6	16537	2756	31.08
RESIDUAL	53	4700	89	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	19.85			
Prt	Pretest scores	.87	.108	.90	.000***
MRH	Melody,rhythm,&harmony trt.grp.	-2.2	4.83	.46	.65
MR	Melody with rhythm trt. grp.	1.23	4.48	.28	.78
M	Melody only treatmt. group	-3.57	4.06	.88	.38
InE	Partic.† in instrumental ens.	-6.34	5.64	1.12	.27
CIE	Partic. in both choral & instr.ens	6.26	2.73	2.3	.03 *

† at least one year participation in high school ensembles

***Significant at .1%   *Significant at 5%

was removed for the final regression model. This last model seems best (Table 4.29). It shows two predictor variables, pretest and CIE, accounting for 75% of the variance. In this model the variable, participation in both choral and instrumental ensembles (CIE),

Table 4.29. ANCOVA, Model 6
Multiple Regression Y: Posttest 5 X variables

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.88	.78	9.44

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	5	16424	3285	36.9
RESIDUAL	54	4812	89	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	15.46			
Prt	Pretest scores	.85	.10	8.87	.000***
MRH	Melody,rhythm,&harmony trt.grp.	-1.93	4.84	.40	.70
MR	Melody with rhythm trt. grp.	.34	4.42	.08	.69
M	Melody only treatmt. group	-3.85	4.01	.95	.35
CIE	Partic. in both choral & instr.ens	5.67	2.69	2.11	.04 *

† at least one year participation in high school ensembles
***Significant at .1%　　*Significant at 5%

shows significance at p<.05, thus reaffirming the significant effect that performing in both types of ensembles has on chunking abilities as manifested by aural musicianship proficiency.

The last step in validating the results of the ANCOVA is to test the model for interactions. This is necessary because there were significant differences noted among the treatment levels (MRH, MR, M), pretest (Prt), and participation in both choral and instrumental ensembles (CIE) which were not significant across all four treatment groups.[19] Therefore, three variables were created to test interactions as follows: (1) MRH

[19]If the the interactions are nonsignificant then the effects of these variables when plotted for each of the treatments will yield parallel lines. Significant interactions will yield lines that would intersect on a graph. This would indicate that the effect of the CIE, for example, would be different across the treatments, and this difference would then have to be analyzed by splitting the group into those who had CIE and those who

x Prt;[20] (2) MRH x CIE; and 3) M x CIE.[21] There were no significant interactions when these variables were entered into the regression analysis,[22] thus, validating the model. As a final check of the ANCOVA model, a multiple regression was run using only the pretest as a covariate and the treatments as predictors. This model accounts for 73% of the score variance.[23] However, the model which includes CIE (participation in both choral and instrumental ensembles) as a covariate along with the pretest, accounts for 75% of the variance, thus making it a slightly more informative model for predicting posttest score effects.

Results of Analyses

The above process of analysis of covariance, involving multiple regression with two covariates – pretest scores (Prt) and participation in both choral and instrumental ensembles (CIE) – yields the following mathematical model:[24]

$$Pst = \beta 0 + \beta 1\ (MRH) + \beta 2\ (MR) + \beta 3\ (M) + \beta 4\ (Prt) + \beta 5\ (CIE)$$

In other words, in this experiment, the posttest score (Pst) is determined by the effect of the treatments, the pretest score (Prt), and participation in both choral and instrumental ensembles (CIE). Those effects can be computed using the values from Table 4.25, as follows:

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did not, which would result in yielding different formulas for predicting scores across the treatment groups and CIE values. (Hinkle, pp. 311-313.)

[20]MRH was significantly correlated to the pretest but the other treatments were not. A variable was computed to test possible interactions by multiplying the MRH variable with the pretest.

[21]MRH and M were significantly correlated to the CIE variable (participation in both choral and instrumental ensembles), but MR was not. Thus, two more variables were computed to test possible interactions by multiplying MRH with CIE, and multiplying M by CIE (participation in both choral and instrumental ensembles).

[22]see Table 4.43, p. 145.

[23]*Ibid.*

[24] β stands for the beta coefficient, or the effect of the predictor variable. β0 is the effect of the intercept which would be used if the model were plotted on a graph. The value of the intercept can be found in the beta coefficient table found in the regression model in Table 29, p. 103.

$$Pst = 15.46 + (-1.93)(MRH) + (.34)(MR) + (-3.85)(M) + (.85)(Prt) + (5.67)(CIE)$$

In this model the control group (C) is used as the baseline model, i.e., when MRH, MR, and M are "0"s in the model. Statistically the program differences noted in this equation are not significant which we know from the levels of significance seen in the multiple regression (see Table 4.29, p. 103). Therefore, the null hypothesis, which predicts no significant difference between the mean posttest score of each group ($p < .05$) after adjustments have been made for pretest scores and background variables by the analysis of covariance, should not be rejected.

$$H_0: \mu\ (MRH) = \mu\ (MR) = \mu\ (M) = \mu\ (C)$$

Thus, group MRH, the holistic musical context with melody, rhythm, and harmony, did not yield a significantly greater mean posttest score than the other groups after adjusting for pretest scores. Neither did group MR, the context of pitch and rhythm, yield a significantly greater mean posttest score than M or C after adjusting for pretest scores. Group M, the melody only context, also did not yield a significantly greater mean posttest score than the control group, C. However, after the scores have been adjusted for pretest (Prt) and participation in choral and instrumental ensembles (CIE), one can predict that students in the MRH (melody, rhythm, harmony) group will score about 1.9 percentage points less on the posttest than those in the control group. MR (melody and rhythm) group members will score about the same (1/3 point higher), and the M (melody only) group will score about 3.8 percentage points less on the posttest than those who are not in their group. One can expect to be able to predict scores for those students who were not in a treatment group, on the basis of pretest score and CIE (participation in both choral and instrumental ensembles) effects as shown in the above formula.

A secondary hypothesis tested the effects of the background variables on the students' chunking ability as measure by posttest scores. It has been demonstrated that participation in both high school choral and instrumental ensembles has a significant effect on posttest scores. The score effect shown in Table 4.29 (p. 103) is, in fact, 5.67

percentage points higher than those students who did not participate in both ensembles. Therefore the second null hypothesis which predicts that there will be no significant effect of musical background as measured by the posttest scores should be rejected:

H_0: a Prt + a musical background = a Prt

In summary, the results of the final regression model, drawn by analysis of covariance, indicate that pretest and participation in choral and instrumental ensembles are significant predictors of ear-to-hand skills whereas the treatments are not. Therefore, the null hypothesis is not rejected in the first hypothesis which predicts a treatment effect, and is rejected in the second hypothesis which predicts the musical background effects. Thus, analysis of covariance demonstrates that students' participation in both junior high and high school choral and instrumental ensembles (CIE) contributes beyond the effect of pretest scores when determining their ability to chunk melodic phrases as measured by posttest scores. Even though the treatments in the intervention stage did not significantly effect chunking ability, this finding about the musical background is considered consistent with the premise upon which both hypotheses were based. That is, aural musicianship is developed best in students who are exposed to holistic musical environments which can be considered analogous to music ensemble experiences, and can, therefore, call upon chunking as a mechanism for the memory and performance of melodic phrases.

CHAPTER V

RESEARCH RESULTS

The results which can be drawn from an analysis of the data in this experiment are as follows.

(1) There was no significant effect of the treatment on chunking, but trends did emerge among the treatment groups which give justification for future study.[1]

(2) Musical background variables of the students are better predictors of chunking ability as measured by a test of aural musicianship than the results of a short-term treatment. Specifically,

(a) there was a significant impact of private lessons (Lsn), playing a fingered major instrument (FMI), participating in an instrumental ensemble (InE) and participation in both school choral and instrumental ensembles (CIE) on aural musicianship as diagnosed by pretest scores to assess baseline skills; and

(b) there was a significant impact of participation in both school choral and instrumental ensembles (CIE) on chunking ability, as measured by the posttest, over the effect of the 12-week treatment.

These results suggest implications for a phase 2 study with the present research sample, recommendations for future study to explore a treatment effect with college music students, as well as future study to examine the effect of musical background on music and non-music students. Strategies for college music student evaluation and retention are also

[1]Glossary of treatment group labels: MRH = Melody with rhythm and harmony group; MR = Melody with rhythm group; M = unaccompanied melody group; C = control group.

recommended in this section. In addition, some projections have been made about the impact of these findings on future studies and teaching and learning strategies related to the school music program.

Chunking Implications for College Music Programs

The strongest result of this study is the finding that shows the significant impact of participation in both school choral and instrumental ensembles (CIE) on aural musicianship, and, furthermore, that the musical background variables are better predictors of chunking ability than a short-term treatment. This finding supports a main hypothesis in this study, i.e., that being exposed to a variety of musical experiences and musical contexts may increase aural musicianship through engaging the chunking mechanism. Chunking calls upon familiar contextual structuring devices which have been stored in the long-term memory in order to link numerous items in the memory. These structuring devices of melody, rhythm, and harmony are most evident in musical ensembles such as chorus, band and orchestra, and, according to this study, accounted largely for the increases in the memory and performance of melodic patterns as measured by the posttest.

Chunking involves focusing on music perception as a Gestalt rather than in separate learning parts because it is a hierarchical memory strategy. Therefore, it seems logical to assume that participation in both choral and instrumental ensembles (CIE) represents true advantages for students in developing the chunking ability necessary for the memory and performance of melodic phrases. In fact, participation in both choral and instrumental ensembles gave students a 5.67 percentage point advantage on the posttest score after being adjusted for the effect of the pretest.[2] Even though analysis of covariance predicts that M (melody only group) scores 3.85 points lower, MRH (melody with rhythm and harmony group) scores 1.9 points lower, and MR (melody with rhythm group) scores .34 points higher than the control group, on the average, a member of any treatment group with CIE

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[2]see ANCOVA Model 6 in Table 4.29, p. 103.

can expect to add 5.67 points to the posttest score. In other words, on the average, a member of any treatment group (MRH, MR, and M) with CIE experience can be predicted to score higher than a member of the control (C) group with no CIE experience.

Other studies have revealed related findings about musical background or ensemble participation. Froseth found in a study of college music majors that placement in ensembles is related to aural musicianship.[3] Kuehn's study found that music theory grades are related to ear-to-hand skills, but grades in private lessons are not.[4] Studies by Kehrberg, Rainbow, and Harrison also link musical background and theory grades to musical aptitude.[5] Harrison found that the best predictors of achievement in freshman music theory classes are academic ability and achievement, musical experience, and performance on more than one instrument. Unfortunately, her research did not include participation in music ensembles as a predictor in her analysis. This study supports these earlier findings, and strengthens the theories that participative, holistic musical experiences which emphasize the structuring devices in music, do make a difference in the musical memory. Several suggestions for research replication follow to further clarify these findings.

Research Sample: Phase 2

In a follow-up study with the participants in this research sample, similar patterns may emerge which would serve to further validate the effect of musical experiences and musical background (see Figure 5.1). This fresh look at musical progress in phase 2

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[3]James O. Froseth, *A Longitudinal Study of the Relationship Between Melodic Ear-to-Hand Coordination and Selected Indices of Musical Achievement at the University of Michigan School of Music* (unpublished report, 1985).

[4]John Kuehn, "The Correlation of Aural Skills and Grade Evaluation of Undergraduate Music Majors," *Pennsylvania Music Educators Journal* (Spring 1989) : 25-26.

[5]see Harrison, 1990; Kehrberg, 1984; and Rainbow, 1965; Chapter 2, pp. 30-31.

brings up a previous unexplored issue about theory skills grades. Covariates pretest, treatment, and participation in choral and instrumental ensembles (CIE) explained 78% of the variance in the posttest scores of the ANCOVA model explained in Chapter 4.[6] An analysis of theory skills grades could shed some light on some of the unexplained percentage of variance, especially if some of the unexplained variance was revealed to be related to theory skills grades. In the Wilder study, for example, aural theory grades did show a positive correlation to scores on the *Test of Melodic Ear-to-Hand Coordination* (TMEHC).[7] Hence subjects would complete a survey updating their college course work,

Figure 5.1. Chunking Research Sample: Phase 2

Problem: How is current musical involvement related to aural musicianship as measured by the *Test of Melodic Ear-to-Hand Coordination* (TMEHC)?

Hypotheses: (1) Music theory grades are related to TMEHC scores; (2) change in TMEHC score is related to the kinds of musical experiences subjects have participated in since the original experiment; (3) continuation in music as a major is related to TMEHC score.

Research Design: Subjects from original experiment will be re-tested on TMEHC and complete a survey updating musical experiences (N=60).

Methods: (1) re-test on TMEHC
(2) compilation of data on Current Musical Involvement (CMI) survey
(3) analysis of change in TMEHC between posttest and re-test
(4) analysis of CMI variables
(5) analysis of relationship between CMI variables and TMEHC score change

and subsequently, would be re-evaluated on TMEHC. The questionnaire would include their current college enrollment status, whether or not they are still music majors, and their cumulative grade point average (see Figure 5.2). Students would also be asked to list grades in freshman and sophomore theory courses, since the goal of these courses is to improve aural musicianship as aforementioned. It is still suspected that piano skills may

[6]Table 4.29, p. 103.

[7]Wilder, 1988.

play a part in aural skills discrimination, and, therefore, students would be asked about their piano proficiency, as well as their continued private lessons. A survey would also collect information about ensemble participation, and if the students have been a section leader in the ensemble or have had a leading role in a musical or opera production. These questions would be aimed at further assessing the magnitude of background experiences as well as current musical involvement on aural musicianship and the musical memory.

Figure 5.2. Current Musical Involvement (CMI)Survey

Are you currently enrolled in college? If not, list current occupation.
Are you currently a music major? If not, list current major.
What is your cumulative grade point average?
List grades in freshman and sophomore theory courses.
List your major instrument. Private lessons for how many semesters?
List your participation in choral ensembles during college enrollment. Section leader? Leading roles/soloist in musicals/operas?
List your participation in instru. ensembles during college enrollment. Section leader? Chair in ensemble?
Non-piano majors: have you passed piano proficiency requirements? Class piano or private piano for how many semesters?
Score on re-test of TMEHC: [to be completed by tester]

Treatment in Future Studies

Dempster, after much experimentation based on Miller's chunking theory, stated in 1981, that the only issues which remain in memory research concern the relationship between capacity and chunking, that is, "What constitutes an 'internal unit' of memory?"[8] In other words, how is an internal unit of memory expanded by the process of chunking? Although the effect of the treatment on the chunking ability of melodic phrases after 12

[8]Dempster, 1981, p. 88.

weeks of practice is not statistically significant, clues about context were beginning to emerge as a result of the statistical analysis. The treatment effect in this study shows the greatest difference between those students who practiced tapes in a melodic and rhythmic context (MR), and those students who practiced tapes in a melody-only context (M). The MR context scored about 4 points higher than the M group after the scores had been adjusted for the pretest: MR(.34) − M(-3.85) = 4.19. In addition, the MRH group, which practiced the tapes with the most contextual clues, scored about 2 percentage points higher that the M group after the scores had been adjusted for the pretest: M(-3.85) − MRH (-1.93) = 1.92.[9]

The intervention stage in this experiment attempted to give students enough practice on aural skills in order to activate the chunking mechanism. However, it is crucial to realize, that just because a student did not receive a treatment does not mean that the student is unable to "chunk." It can be assumed that students who scored high percentiles on the pretest already had the experiences in the long-term memory to use the chunking mechanism, as is demonstrated in an analysis of background variables which shows that the impact of previous musical experiences, especially ensembles, has the greatest impact on the chunking process. However, it can be pointed out that the students who showed the highest gains tended to be in one of the treatment groups, and most were in groups MR and MRH. Table 5.1 shows the fifteen students who were in the top 25%-gain group.

Table 5.1. Top 25% Gain Scores; N=15 Showing Affiliation with Program

Program:	Count:	Percent:	Change Scores:						
MRH	5	33.3%	28	27	25	24	21		
MR	7	46.7%	33	30	27	24	21	20	18
M	2	13.3%	23	19					
C	1	6.7%	35						

[9]see Chapter 4, Table 4.29, p. 103.

Even though the student with the highest gain was in the control group, the rest of the students were in a treatment group; one third were MRH group members, and nearly one half were members of the MR group. Only two of the fifteen students were in the melody-only group (M).

Some assumptions may be made, therefore, that rhythmic and harmonic structuring experiences are stronger in persons that have had a longer exposure to music – through private lessons, participation in ensembles, and experience playing a fingered musical instrument – and, therefore, have higher aural skills. Consequently, those students with lower aural skills, such as the students in the MRH group who had a significantly lower pretest mean than melody-only (M) and control (C) groups, and group MR who had a significantly lower pretest mean than the control group,[10] benefitted more from the treatment. It also follows that a longer treatment period may show a significant difference between the pre- and posttests, especially for these students with less musical background and lower pretest scores. Moreover, there is evidence that treatment can give a very different effect if implemented for one year as opposed to one semester as is discussed below.

Rutkowski launched a year-long study comparing the effectiveness of individual and group singing activities on the kindergarten child's use of the singing voice. Mid-year testing and posttesting yielded contrasting conclusions.[11] The experimental group scored significantly higher than the control group on mid- and postests of tonal aptitude (using PMMA test[12]), and higher on rhythm aptitude only on the midtest. Additionally, the

[10]see Chapter 4, Table 4.15, p. 88.

[11]Joanne Rutkowski, "The Comparative Effectiveness of Individual and Group Singing Activities on Kindergarten Children's Use of Singing Voice and Developmental Music Aptitude," (unpublished paper presented to Music Educators National Conference, Washington, D.C., March 30, 1990), p. 8.

[12]Edwin E. Gordon, *Primary Measures of Music Audiation* (Chicago: G.I.A., 1979).

experimental group's gain on a singing voice development measure (SVDM) did not emerge as significant until the posttest. Rutkowski concluded that the results would have been much different had the study been conducted for only one half year. A one-year study may also have impacted Stauffer's 1985 study involving a comparison of melodic and harmonic contexts on the singing skills of children. She concluded that harmonic context may be more beneficial to older children than younger children, because, even though singing skills did improve with training tapes, there were no significant differences among a variety of contexts over the twelve-week length of the treatment. In Dunlap's study, a fourteen-week treatment of singing in an instrumental class yielded no significant differences in aural performance or reading skills.[13] He did, however, find a positive correlation between vocal accuracy scores and *Test of Melodic Ear-to-Hand Coordination* (TMEHC) scores which leads one to believe that significant findings may have emerged in a similar one-year study. Studies by Hicks and Zimmerman were one- and two-year studies respectively, and gave stronger results.[14] In terms of this study, then, it is the recommendation of this researcher that treatments be implemented for the span of one academic year, as opposed to one semester in order to yield greater effects.

A larger research sample would also insure a more random study. MR and MRH did show the largest gains respectively between pre- and and posttest scores – 14.1% and 12.7% – and a larger sample may have augmented these changes. Consider the following hypothetical situation. Suppose the research sample were 240, four times the size of the original sample. In order to provide an example in Table 5.2, each of the subjects was entered into the data four times, so that the mean and range of the scores would remain the same as in the original data set. However, because of the increase in the sample size, the standard error is decreased and the degrees of freedom for error are approximately

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[13]see Stauffer, 1985, Chapter 2, p. 24; and Dunlap, 1989; Chapter 2, p. 32.

[14]see Hicks, 1987, Chapter 2, p. 24; and Zimmerman, 1969, Chapter 2, p. 26.

Table 5.2. Comparison in Change Scores Analysis when N=60 and N=240

N=60:	Count:	Mean:	Std. Dev.:	N=240:	Count:	Mean:	Std Dev.:
Overall	60	12	9.24	Overall	240	12	9.19
MRH	18	12.7	9.3	MRH	72	12.7	9.1
MR	17	14.1	10.1	MR	68	14.1	9.9
M	13	9.8	8.0	M	52	9.8	7.7
C	12	10.4	9.5	C	48	10.4	9.1

quadrupled. Therefore the difference in change among the groups becomes significant in an analysis of variance as shown in Table 5.3. The original analysis of variance of change scores when the research sample size is 60 is shown in Table 5.4 (p. 116). However, in a

Table 5.3. Analysis of Variance of Change Scores by Program when N=240

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	3	704	235	2.8
Within groups	236	19464	82	p=.04
Total	239	20168		

Comparison:	Mean Difference:	Fisher PLSD:
MRH vs. MR	-1.4	3.0
MRH vs. M	-2.9	3.3
MRH vs. C	2.3	3.3
MR vs. M	4.3	3.3*
MR vs. C	3.7	3.3*
M vs. C	-0.6	3.6

* Significant at 5%

study replication, one must concede that these problems of size and treatment period may be implicit in the design. It is doubtful that the enrollment of the freshman theory skills classes would remain intact for two semesters, and less likely that many colleges would have an enrollment of 240 freshman music majors during one school year.

Table 5.4. Analysis of Variance of Change Scores by Program when N=60

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	3	176	59	.675
Within groups	56	4866	87	p=.571
Total	59	5042		

Comparison:	Mean Difference:	Fisher PLSD:
MRH vs. MR	-1.4	6.3
MRH vs. M	-2.9	6.8
MRH vs. C	2.3	7.0
MR vs. M	4.3	6.9
MR vs. C	3.7	7.0
M vs. C	-0.6	7.5

* Significant at 5%

An additional logistical problem in the design was the availability of the piano lab. Students had to begin the class period in the piano lab in order to practice the training tapes, and then move to their theory classroom. This proved cumbersome for the theory teachers, and some class time was wasted moving from room to room. A possible solution to this problem would be to launch this experiment in class piano which meets in the piano lab, and concentrates solely on piano skills. The analysis of the fingered major instrument (FMI) variable gives ample justification to incorporate the experiment in class piano. Pretest scores were significantly related to the FMI and Lsn variables, showing that facility on a fingered major instrument and at least one year of private music lessons on any instrument were helpful to success on the ear-to-hand test of aural musicianship. However, after treatment, FMI was not a significant predictor of posttest scores (see Table 5.5). This could be due to the treatment which perhaps, helped to strengthen the students' keyboard skills, providing the necessary kinesthetic association to improve ear-to-hand skills.[15]

[15]The private lessons variable also was not related to the posttest scores, but, in this case, it is more probable that the impact of past private lessons could have been lessened by the fact that all students were taking private lessons on their major instrument in the first semester of their freshman year when the treatment was in progress.

Table 5.5. FMI Variable: Comparison of t-tests for Pretest and Posttest Scores

FMI:	Count:	Percent:	Pretest μ	Std. Dev:	Posttest μ	Std. Dev.:
NO	21	35 %	29.3	15.0	43.1	16.4
YES	39	65%	39.5	19.2	50.0	19.9
			t-test:	-2.1	t-test:	-1.3
			P-value:	p=.04*	P-value:	p=.18

*Significant at 5%

Given the problems discussed above concerning the length of treatment, sample size, and access to the piano lab, a more reasonable research design is to replicate the treatment with freshman class piano students, increase the duration to one year if possible, and divide students between two treatment groups only (M and MRH, or M and MR) in an attempt to increase group size. The elimination of the control group might be argued on the basis of previous studies which have shown the efficacy of aural training through ear-to-hand training tapes.[16] In this case, it is the recommendation of the researcher that the students receive treatment M and MRH because treatment MRH is most consistent with the background variable finding about the significance of participating in music ensembles, since ensembles are experienced in a melodic, rhythmic and harmonic context. The replication model, shown in Figure 5.3 (p. 118), uses the same treatment tapes, pre- and posttesting, and musical background survey[17] as in the original experiment. Likewise, similar analyses are suggested with the addition of an analysis of change between low and high pretest subjects.

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[16]see Wilder, 1988, Delzell, 1983, and Dickey, 1991, Chapter 2, p. 33; Humphreys, 1986, Chapter 2, p. 34; and Stauffer, 1985, p. 24.

[17]see Aural Skills Experiment Survey, Chapter 3, Figure 3.18, p. 67.

Figure 5.3. Research Replication: Treatment Tandem to Freshmen Class Piano

Problem: In which aural training context can the chunking memory processes be most effective in improving ear-to-hand skills: melody only (M), or melody with rhythm and harmony (MRH)?

Hypotheses: (1) MRH context is more effective in improving ear-to-hand skills; (2) aural training is strongest predictor to subjects with low pretest scores among the variables analyzed from musical background survey; (3) musical background is strongest predictor among these variables to subjects with high pretest scores.

Research Design: Freshman class piano students will practice a training tape (same tapes as used in previous study) 3 times a week for 10 minutes, in an electronic piano lab for 2 semesters. N=60 (30 @ group)

Methods: (1)pre-, mid-, and posttesting on the Test of Melodic Ear-to-Hand Coordination (TMEHC).
(2) compilation of background data on a Aural Skills Experiment survey
(3) analysis of pre- and posttest differences
(4) analysis of baseline variables
(5) analysis of change between low and high pretest subjects

Tests in Future Studies

An alternative to designing another treatment in order to answer Dempster's question about what constitutes an "internal unit" in musical memory, would be to consider a replication with a one-time test in lieu of a treatment. Dempster's experiments, acting on Miller's chunking theory, found that speed in identifying items is increased by chunked learning. Booth and Cutietta also found this was true in a test of musical memory of familiar tunes. They asked subjects to remember as many familiar tunes as possible from a test tape, and to write them down after listening. Subjects were told that the tunes were drawn from a variety of musical styles. They found that people readily categorize familiar music by "style" even though there is no suggestion to do this. These results suggest the importance of teaching proper musical categorization strategies, which is implicit to the chunking process. Booth and Cutietta's study supports the theory that chunking can facilitate music learning because, the authors assert, "like verbal learning, music learning involves a categorization of stimuli based on holistic classification."[18] Therefore, a test to explore the organizational structures in music which enable the process of chunking in the musical memory could involve playing musical examples and asking college students to assess statements about meter, mode, and harmonic progressions in contexts with and without an harmonic background, in order to determine which musical context induces the more accurate answers. Students would have to remember the examples in their entirety because statements about either meter, mode, harmony, or form would be given after the music example was played. Freshman music majors would be tested in the second semester to insure that musical terms learned in the first semester of theory were familiar to all students. This model is summarized in Figure 5.4.

Figure 5.4. Research Replication: Memory of Musical Structures Test (MMST)

Problem: In which musical context – with or without an harmonic background – can statements about musical structure be more accurately assessed in a battery of short musical examples?

Hypotheses: (1) Harmonic context is more conducive to accuracy in a test of musical structure than a melody-only context; (2) Test of Melodic Ear-to-Hand Coordination (TMEHC) and baseline variables show a relationship to Memory of Musical Structures Test (MMST) score.

Research Design: All freshman music majors will be tested in second semester theory classes; half will take MMST in melodic context only; the other half will take MMST with harmonic context. N=60 (30 @ group)

Methods: (1) development of a test of short 100 music examples (MMST)in a variety of meters and modes based on primary chord progressions. Two structural statements (A & B)will be given after each example is played; subjects will list A or B as correct statement.
(2) diagnostic testing to determine aural skills proficiency using MEHT
(3) compilation of data on a musical background survey
(4) analysis of MMST score differences between groups
(5) analysis of baseline variables
(6) analysis of relationship of MEHT and baseline variables to MMST score

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[18] Gregory D. Booth and Robert A. Cutietta, "The Applicability of Verbal Processing Strategies to the Recall of Familiar Songs," *Journal of Research in Music Education* 39 (Summer 1991) : 129-130.

Levelt's 1970 study provides another model for musical replication in order to research what constitutes an "internal unit" of musical chunking.[19] In his study, subjects listened to a tape of spoken text over which were superimposed a series of clicks. After listening, the subjects were given a copy of the written text and asked to write in where they remembered hearing the clicks. He found that students tended to mark the clicks at the endings of phrases or sentences, even when the clicks actually occurred just before or just after phrase endings, indicating that the memory naturally divides text into syntactical "chunks" for recall. A musical application of this model is outlined in Figure 5.5, the Musical Memory Interruptive-Stimulus Survey (M-MISS). The M-MISS would be

Figure 5.5. Research Replication:
Musical Memory Interruptive-Stimulus Survey

Problem: Does the addition of harmony and rhythm to a tonal pattern cause interference in remembering the placement of a non-musical auditory stimulus superimposed on the pattern?

Hypotheses: (1) The addition of harmony and rhythm to a tonal pattern causes interference in remembering the placement of a superimposed "click" on the Musical Memory Interruptive-Stimulus Survey (M-MISS); (2) Test of Melodic Ear-to-Hand Coordination (TMEHC) and baseline variables show a relationship to score on M-MISS.

Research Design: All freshman music majors will be tested in first semester theory classes; half will take M-MISS in melodic context only; the other half will take M-MISS with harmonic context. N=60 (30 @ group)

Methods: (1) development of a test (M-MISS) of short 100 music examples in a variety of meters and modes based on primary harmonic chord progressions. Interruptive non-musical clicks will be superimposed on each example. Subjects must choose correct click placement in the musical score which is projected on a screen after a 5-second delay.
(2) diagnostic testing to determine aural skills proficiency using TMEHC
(3) compilation of data on a musical background survey
(4) analysis of M-MISS score differences between contexts
(5) analysis of baseline variables
(6) analysis of relationship of TMEHC and baseline variables to M-MISS score

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[19]see Levelt, 1970, Chapter 2, p. 16.

composed of accompanied or unaccompanied musical examples with superimposed clicks, and students would be asked to choose the correct click placement from a score projected on a screen five seconds after hearing the example. It is hypothesized that the markings of the clicks would give clues about the organizational structures in music that are most responsible for shaping an internal chunk of musical memory. Half of the musical items would be embedded in a rhythmic and harmonic context (MRH), and half would be in a melody-only (M) context. The scores on each half of the test would be examined for differences. The results would imply which context causes the most interference to remembering the timing of the clicks, thereby inferring the musical basis of the strongest chunked internal unit.

A model for a future study should include a survey of college students who are non-music majors. How do non-music majors use chunking skills in musical recall? Clifford Madsen and Myra Staum found that the ability of non-music majors to discriminate between melodies was related to either mode or meter.[20] Kehrberg's descriptive study of 169 fourth- through twelfth-graders also demonstrated that participation in musical experiences both inside and outside of school are strong predictors of general music achievement.[21] Surveying the background of non-music majors and comparing this information to their scores on music aptitude tests (MAP[22]), would lend additional information to this study and to previous studies on the relationship of musical background and musical aptitude. The experiment model, which is shown below in Figure 5.6, targets students who would be enrolled in introduction to music courses.[23] Students would be given the Music Aptitude Profile test and asked to complete a musical background survey

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[20]see Madsen and Staum, 1983, Chapter 2, p. 25.

[21]Kehrberg, *ibid.*

[22]Edwin E. Gordon, *Music Aptitude Profile* (Boston: Houghton Mifflin, 1965).

[23]Introduction to Music fulfills a distribution requirement of one arts course at Indiana University of Pennsylvania. Students can choose Introduction to Music, Introduction to Art, or Introduction to Theatre.

as is illustrated in Figure 5.7. The results of this analysis would add to the research base about the relationship between musical perception and participation in music ensembles of non-music majors as compared to music majors.

Figure 5.6. Research Replication: Relationship of Musical Background and Musical Aptitude

Problem: How is musical background related to musical aptitude as measured by the Music Aptitude Profile (MAP)?

Hypotheses: (1) Music ensemble experiences are related to MAP scores; (2) experience of private lessons is related to MAP scores; (3) present involvement in music is related to MAP scores.

Research Design: Subjects will be non-music majors enrolled in introduction to music courses (N=200).

Methods: (1) administering MAP
(2) compilation of data on Non-music Major Musical Background Survey (NM-MBS)
(3) analysis of NM-MBS data
(4) analysis of relationship between NM-MBS data and MAP scores

Figure 5.7. Non-music Majors Musical Background Survey (NM-MBS)

List college year and major.
What is your cumulative grade point average?
Have you taken any private music lessons? What instrument(s)? How many years of lessons pre-college? How many years of lessons during college?
List your participation in school choral ensembles, grades 7-12. How many years?
List your participation in school instrumental ensembles, grades 7-12. How many years?
List your participation in choral ensembles during college enrollment. How many semesters?
List your participation in instru. ensembles during college enrollment. How many semesters?
Are you involved in any community music activities? Please list activities; years of involvement; current involvement.
MAP Score: [to be completed by the tester]

Applications

. Since using chunking in the learning process depends on two conditions – knowledge of the previous experiences of the subjects and the manipulation of training procedures to enable chunking – some strategies for college music student evaluation and retention can also be gleaned from these data. Strategies may help to pinpoint deficiency areas of incoming freshman music majors (see Figure 5.8). Froseth suggests using the *Test of Melodic Ear-to-Hand Coordination* (TMEHC) as a diagnostic tool for entrance to college music programs because of its reliability in predicting success as a music education major.[24] This diagnostic tool along with a survey about musical background could help students and advisors to recommend what types of college courses would most likely impact students' auditory skills. For example, playing a fingered major instrument (FMI), taking private lessons (Lsn), and participation in music ensembles (InE, CIE) boosts pretest scores. Therefore, voice or percussion majors could be encouraged to study piano, a wind, or string instrument early in their college program, because achieving a high degree of proficiency on these instruments may boost auditory skills. In addition, playing these instruments in a musical ensemble might help to provide experiences to enable the chunking mechanism to improve musical discrimination and musical memory. Those students who have not participated in both choral and instrumental ensembles should be encouraged to do so in college. In addition, studies by other researchers – such as Boyle and Lucas[25] who found that a tonal, harmonic accompaniment does improve the sight singing accuracy of college music theory students, and Humphreys whose research points to training and harmonic context – lend support to targeting specialized aural training programs. Specifically, those students who have particularly low scores may benefit from

[24]see Froseth, 1982, Kuehn, 1989, and Wilder, 1988, Chapter 1, pp. 8-9; and Sang, 1982; Chapter 2, p. 34.

[25]see Boyle and Lucas, 1990, Chapter 2, p. 24.

Figure 5.8. Research Application: Individual Advising Plans to Address Aural Skills Deficiencies with College Music Majors

Research Result: College students who have taken at least one year of private music lessons (LSN), play a fingered major instrument (FMI), have participated in an instrumental ensembles (InE),and who have participated in both choral and instrumental ensembles (CIE) have a higher level of aural musicianship as measured by Test of Melodic Ear-to-Hand Coordination (TMEHC) than those students who do not have those previous experiences.

Implications for Teaching and Learning: College students can be advised at the beginning of their freshman year about their strengths and weaknesses in aural music skills by analysis of scores on a diagnostic test of aural musicianship, and through analysis of a musical background survey.

Recommended Strategy: Develop an individual advising plan for students whose background and TMEHC score show deficiencies. Such a plan would include the following:
(1) Diagnose aural musicianship with TMEHC.
(2) Collect and analyze data on a musical background inventory.
(3) Make recommendations based on background deficiencies. These recommendations might include any of the following that are relevant to the student:
- (a) study piano and/or FMI early in college program.
- (b) participate in an instrumental and a choral ensemble.
- (c) begin an aural skills training program such as MRH Melodic-Ear-to-Hand Skills Program imitating melodic patterns on keyboard or major instrument, in addition to freshman theory classes.
- (d) have periodic evaluations including a re-test of TMEHC at the end of every academic year.

an ear-to-hand training program in a rhythmic and harmonic context which most closely approximates the musical environment in large ensembles[26].

In summary, a replication of the treatment should be considered with a larger research sample and a longer intervention period. As an alternative, a one-time test is recommended which would help diagnose the musical structures which are most vital to the chunking process. The advantages of a test rather than a treatment are the availability of a large group, and practicality in completing data; the disadvantages are that this type of

[26]Wilder, 1988.

research removes the performance aspect of the experiment in analyzing how one remembers melodic patterns. Finally, chunking strategies can be used to recruit, diagnose, and retain future college music students.

Chunking Implications for School Music

Based on results of this experiment, implications can be made about the application of chunking theory to the school music program. In the elementary school, harmonic discrimination tests, harmonic training programs, and a survey of family activities in music may serve to examine chunking in the development of children's musical perception. The chunking process may also help to integrate music with other learning areas such as a whole language curriculum unit. In the secondary schools, chunking research results point to recommended strategies to increase participation in musical activities, a plan to link chunking and creativity, and an ancillary recommendation for research about attendance and attitude.

Elementary School Curriculum

The results of this dissertation can be applied to future designs which would study how the chunking process can be used as a structuring process in the general music classroom, facilitating the implementation of a larger research base on the teaching and learning of music.[27] This project emphasizes the development of aural skills, by teacher modeling and student imitation, through which the musical memory can be increased.

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[27] The University Lab School at IUP is an ideal setting for the application of innovative research for music teaching and learning in the elementary grades. The current curriculum focus employed by Dr. John Kuehn and myself, in IUP's music education methods classes and at the University Laboratory School, is largely based on the research findings of Dr. James O. Froseth of The University of Michigan.

National attention is given to the measurement of music aptitude and ways in which musical achievement can be increased in the teaching of young children.[28]

Of particular relevance to this study is the use of harmonic context in the teaching of young children, because of its relationship to the background findings about participation in music ensembles. Figure 5.9 offers a model to examine the relevance of harmonic context in the musical perception of children. Previous studies have inferred that children have more singing success imitating melodic patterns than they do repeating single notes or scales.[29] Based on this research, it can be theorized that harmony constitutes the basic internal unit in musical memory. Gordon's taxonomy of tonal patterns, for instance,

Figure 5.9. Research Replication:
Same or Different in Melody-only and MRH Context Test (M-MRH)

Problem: Is a child's memory of melodic phrases enhanced by a rhythmic and harmonic background?

Hypotheses: (1) The addition of harmony and rhythm to a melodic pattern enhances a child's discrimination of melodic patterns when comparing the score of the M half with the score of the MRH half; (2) There is a positive relationship between family music activities (FAM) and test scores; (3) There is no significant correlation between impact of context and grade level of student.

Research Design: N=60: 2nd-, 3rd-, and 4th- graders at the IUP University Lab School will be tested on PMMA and M-MRH. Information will also be collected from the students parents about family activities in music (FAM).

Methods: (1) development of test ,"M-MRH," which is composed of 50 short music examples based on primary harmonic chord progressions: 25 in M context; 25 in MRH context.
(2) administer PMMA rhythm and tonal test
(3) distribute and complete FAM questionnaires to parents
(4) analysis of M-MRH score differences between test items
(5) analyze relationships among PMMA and M-MRH scores, and FAM info.
(6) analyze score differences among grades

[28]Margaret Merrion, ed., "Special Focus: Research in the Music Classroom," *Music Educators Journal* 77 (November 1990) : 22-51.

[29]see Flowers, Dunne-Sousa, 1990; Jones, 1972; Goetze, *et. al.*, 1990, Chapter 2, p. 29.

is based largely on primary chord progressions. However, Gordon claims that tonal pattern training should be administered without harmonic background, and further advocates teaching music elements separately to young children until music aptitude is stabilized at about age nine. A replication study emphasizing use of harmonic context with younger students would challenge this theory. In the model shown in Figure 5.9 (above), second-, third-, and fourth-grade students would be administered a one-time test in which they would decide whether two melodic patterns are the same or different. Half of the test items would be in a melodic context only, and half would have a harmonic background. Students would also take the tonal and rhythmic portions of PMMA, and parents would be interviewed to complete a Family Activity in Music Survey (FAM), see Figure 5.10.

Figure 5.10. Family Activity in Music (FAM) Survey

Child's Name: Age: Yrs. Mo. Grade:

Do you have a piano in your home?

Does your family sing together:
often? sometimes? occasionally? seldom? not at all?

Do (or did) you sing lullabies or other songs to your child?
often? sometimes? occasionally? seldom? not at all?

Please list the musical instruments that family members can play.

Family member:	Instrument(s):	How many yrs?	Yrs. of Lessons:	Still play?
Child:				
Mother:				
Father:				
Siblings:				
(list ages)				

Please list the names of the music ensembles in which your family members participate.

Family member:	Instru. Ensemble:	Dates?	Choral Ensemble	Dates?
Child:				
Mother:				
Father:				
Siblings:				

Do any adult members of your family have music as a career, or avocation?

Fam.Mem:	Career	Avocation	Duties/Activities	Full-time	Part-time
Mother:					
Father:					
Siblings:					

Parents, please check number of years of education below:

Mother: less than 12____ 12____ 13-15____ 16____ 17-20____
Father: less than 12____ 12____ 13-15____ 16____ 17-20____

It is hypothesized that the family's music involvement will have an impact on test scores, whereas grade level is not theorized to show differences between types of test items. Other variables to look at would be the educational level of the parents.

Gordon developed with David Woods the text series, *Jump Right In,*[30] for elementary grade children which includes a separate tonal and rhythmic training program. Based on the results of this study and possible future findings, a training program which stresses harmonic changes may be advantageous to the development of children's musical aptitude. Humphreys found that melodic echo playing is highly correlated with harmonic audiation. Although Stauffer's study is inconclusive, she also maintains that harmonic context and harmonic discrimination can support the development of children's singing voices.[31] The idea of emphasizing harmonic context with very young children refutes the principles of singing pentatonic patterns, which are stressed by some contemporary elementary music methods, specifically song materials used in methods associated with Kodály and the Orff-*Schulwerk*. The following research model is aimed at testing the effectiveness of an harmonic training program with first-grade children to enhance musical perception and possibly to boost musical aptitude as measured by PMMA scores. Harmonic chord progressions are not usually stressed until the upper elementary grades. In this experiment, children in a treatment group would be exposed to singing, playing, and moving to songs with tonic and dominant chord changes through teacher modeling and student imitation. A second treatment group would be exposed to unaccompanied singing through teacher modeling and student imitation using songs with no implied harmonic changes (i.e., pentatonic melodies).[32] Students would be pre-and posttested using the

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[30]Edwin E. Gordon, *Learning Sequences In Music: Skill, Content, and Patterns* (Chicago: G.I.A. Publications, Inc., 1988), p. 205.

[31]Humphreys, 1986, and Stauffer, 1985.

[32]It would not be advisable to designate a control group in this experiment because of the difficulty of defining "traditional first-grade music instruction," against which comparisons would have to be drawn.

PMMA as a test instrument and, also, parents would be interviewed to determine the family's activities in music (see Figure 5.10, FAM). The research model is outlined in Figure 5.11 as follows.

Figure 5.11. Research Application;

First Grade: Children's Harmonic Instruction Program (CHIP)

Problem: Is an harmonic training program beneficial to the development of musical perception in young children?

Hypotheses: (1) An aural training program with harmonic changes will improve children's perception of the structuring elements of music ("chunks") necessary to the development of musical perception; (2) There is a positive relationship between family music activities (FAM) and test scores.

Research Design: N=60: Children from 4 first-grade classrooms who receive 60 minutes of music instruction per week. Length of study: one school year

Methods: (1)Treatment Group, A, (two 1st-gr. classes) would be exposed to singing, playing, and moving to songs with tonic and dominant chord changes through teacher modeling and student imitation.
(2)Treatment group, B, (two 1st-gr. classes) would be exposed to unaccompanied singing through teacher modeling and student imitation using songs with no implied harmonic changes (i.e., pentatonic melodies)
(3) administer PMMA rhythm and tonal test to all students as a pre- and posttest measure
(4) Interview parents to complete FAM questionnaires
(5) analyze differences between treatment groups on pre- and post- scores, and FAM info.

In the elementary school curriculum, chunking research can also help to combine music and academic skills. Stauffer's study found that there is some relationship between reading achievement and musical skills. Whole language theorists (i.e., Edelsky, Goodman and Goodman, Harste) assert that children learn language in specific social and cultural situations. They theorize that information which is taught out of a meaningful context is abstract, difficult to learn, task-specific and often quickly forgotten.[33] Therefore, it appears to be more educationally sound to approach language learning through a variety of content areas. Linking music to language learning was the subject of Hicks study in which rap music was used to learn basic skills in an urban preschool.[34] In other words, she used rhymes to foster the teaching of concepts. This is not a new concept: nursery rhymes are frequently taught as beginning reading experiences; and rhymes are commonly used as memory devices in order to remember the alphabet, days of the week, and the months. Many rhymes have melodies; some do not. If harmony is hypothesized as the basic internal unit in music, then it could also be theorized that rhymes may be remembered more effectively with melodies sung with an harmonic background. Findings by Révész show that children score higher on a rhythm test when it is presented in the form of tunes. Davies research pointed to "templates" in the memory for individual songs, in which a whole song is chunked as one memory unit, with rhythm and implied harmony.[35] A study such as this would have implications for including music as a necessary component of the whole language concept. The creative process inimitable to music as a performing art could become a powerful stimulus, not only to music with its own unique content, but also to the learning of language, literature, and social studies. A folk song from another culture which becomes chunked in the memory as one internal unit, can contain information pertinent to the lifestyle, costumes, and ceremonies of that culture; thus becoming a powerful vehicle for recalling a social studies unit. Figure 5.12 sketches briefly an application of chunking to the whole language unit. In this strategy, the unit is introduced through a hands-on musical activity related to the theme of the unit.

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[33]Susan L. Lytle and Morton Botel, *PCRP II: Reading, Writing, and Talking across the Curriculum* (Harrisburg: The Pennsylvania Department of Education, 1988), p. 17-21.

[34]see Hicks, 1984, Chapter 2, p. 24.

[35]see Révész, 1954, Chapter 2, p. 27; and Davies, 1978, Chapter 2, p. 29.

Figure 5.12. Research Application:

Chunking and Whole Language in the Elementary School Curriculum

Research Result: Holistic musical experiences (manifested by the music background effect of CIE) are effective in activating the chunking mechanism in the musical memory as measured by TMEHC.

Implications for Teaching and Learning: Chunking language and social studies content within a musical context may be an effective tool to introduce, develop, and assimilate learning concepts into the long-term memory.

Recommended Strategy: Introduce whole language units with hands-on musical experiences such as a folk song, dance, or instrumental piece related to the content of the unit. Develop concepts with activities in a variety of learning areas. Begin each new concept with a musical activity. Plan a culminating presentation by the students to include the performing arts.

Junior High and High School Curriculum

In a compilation of music education data prepared by MENC and edited by Daniel Steinel,[36] surveys show that school music participation decreases at the upper grade levels, whereas interest in music measured by listening activities and informal music activities increases (see Table 5.6, p. 132). In addition, scores on the National Assessment of Education Progress in Music show an overall decrease during the same age group: 9 year olds scored 50%; 13 year olds scored 41%; and, 17 year olds scored 43%.[37] According to results in this study, maintaining participation in ensembles is advantageous to improving auditory skills necessary for the chunking mechanism, and thereby could be

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[36]Daniel V. Steinel, ed., *Music and Music Education: Data and Information* (Reston VA: Music Educators National Conference, 1984), p. 41 & 44.

[37]*Ibid.*, p. 73. NAEP, funded by the National Institute of Education, surveys education attainments of 9-, 13-, and 17-year olds in 10 learning areas. Different learning areas are assessed every year, and all areas are periodically reassessed in order to measure possible changes in education achievement. Since 1984, NAEP has been taken over by Educational Testing Service (ETS) in Princeton, New Jersey.

Table 5.6. Inventory of Musical Activities in 9-through 17-Year Olds

Musical Activities:	9-yr olds	13-yr olds	17-yr olds	Increase	Decrease
Instru. Ensembles (1983)		21%	15%		-
Choral Ensembles (1979)	44%	27%	20%		-
Music Lessons (1979)	36%	23%	12%		-
Making up own music (1979)	50%	37%	28%		-
Listening to music (1979)	38%	90%	98%	+	
Singing for fun (1979)	45%	60%	71%	+	
NAEP scores in music (1979)	50%	41%	43%		-

expected to improve NAEP in music scores. Furthermore, interest in music increases during this time period, and therefore, decline in interest is not the reason that students drop out. The largest drop off occurs between the 9- and 13-year olds, during which time music is no longer offered to all students, but, instead, students are subject to the selection process in junior high and high school ensembles. Those students who have not begun instrumental classes in the elementary school are often excluded from the program. In addition, vocal problems during the time of voice change often are a deterrent to a male student's participation in choral ensembles, unless music teachers can meet the challenge of finding a place for the changing male voice in middle school and junior high choruses. And, yet, this study implies that continued participation in school music activities fosters greater skills in musical discrimination than private music study.

Therefore, strategies should be initiated to keep students musically active in general music classes. Activities such as electronic keyboard labs, class guitar programs, and beginning instrumental classes can offer opportunities to this age group in order to keep students with little previous experience active in music. In high school, large music ensembles such as the marching band or large choruses may be able to provide an arena where a "musical novice" may participate in a music activity. Opportunities are also needed to challenge the musical abilities of advanced students, such as, participation in music theory classes taught through access to electronic keyboards and MIDI synthesizers. In fact, the composition majors in this data set had very high pretest scores, but, because there were only two composition students, no conclusions could be drawn about the relationship between that major and aural skills. Given the implications of background variables, it may be hypothesized that students who had music theory classes in high school would score high on a test of aural skills, therefore, it is recommended that future studies target the effect of high school music theory classes. Figure 5.13 outlines a strategy plan for increasing junior high and high school musical activity which addresses these issues.

Figure 5.13. Research Application: Strategies for Increasing Musical Activity in Junior High and High School

Research Result: Musical perception is impacted most by musical background experiences which include active participation in music, specifically in school instrumental ensembles (InE), and in both school choral and instrumental ensembles (CIE).

Implications for Teaching and Learning: Students can continue to develop musically if they an maintain active involvement in music through experiences such as school ensembles.

Recommended Strategy: Develop strategies to provide opportunities for students to remain musically active in school music classes through junior high and high school years. Such opportunities could include the following:
(1) guitar and/or electronic keyboard experience in jr. and sr. high general music classes;
(2) beginning instrumental classes in the jr. high;
(3) instrumental and choral ensembles for the "music novice" in jr. and sr. high schools;
(4) activity-based theory classes to challenge the musically gifted students, and students who seek a career in music.

Chunking for Creativity

Education in music develops imagination, enhances communication through non-verbal as well as verbal means, fosters the acquisition of critical and technical skills, and leads to self-discovery and self-expression.[38] Lutz's chunking study emanated from the desire to apply research to this quality of creativity.[39] She claims that creativity can be

[38]National Commission on Music Education, *Growing Up Complete: The Imperative for Music Education* (Reston, VA: Music Educators National Conference, 1991), p. vii.

[39]see Lutz, 1978, Chapter 2, p. 17.

facilitated by learning strategies such as imagery, pictures, chunking, and analogies. She used these technics in reading and creative writing projects with students. Similar chunking motivational strategies could also be applied in the improvisation and composition of musical phrases. Using the underlying harmonic structure of music is an example of how to use chunking as a strategy to motivate melodic improvisation. This, in fact, is the principal of jazz improvisation, and has implications for teaching composition in the middle school and junior high general music classroom. Creative projects could emanate from a given chord progression, over which students would create melodic material as suggested in Figure 5.14.

Figure 5.14. Research Application: Chunking and Composition

Research Result: Chunking is based upon the familiar structuring devices in music, i.e., its elements – melody, rhythm, and harmony. Harmony may be the basic internal unit in the musical memory.

Implications for Teaching and Learning: Classes in music composition can begin in the upper elementary and middle school general music classroom, through teacher modeling and student imitation of basic harmonic chord progressions.

Recommended Strategy: Composition strategies in the general classroom should be based on the principals of harmonic progression. Example:

> Teach a harmonic progression such as 12-bar blues, through performance with guitar, electronic keyboards, or Orff instruments. Develop improvised melodies based on the progression.

Ancillary Findings: Attitude and Attendance

Kehrberg's study of music achievement in a rural environment shows that music aptitude, home music activities, participation in school music activities and outside music activities are potent predictors of general music achievement in high school students.[40] In addition, he found that school music participation may be correlated to positive attitude. An

[40] N=169 in Goessel, Kansas; Kehrberg, 1984.

ancillary result found in this experiment which may be related to Kehrberg's finding about attitude, is the correlation that was found between attendance in theory skills class and participation in choral ensembles (ChE) and both ensembles (CIE). The students who participated in those school ensembles tended to have a higher attendance record. This result may offer implications about school attitudes and attendance patterns. A future study could examine the "causal" relationship between these two variables. Students in school ensembles may be more self-disciplined in attending class because regular attendance in music ensembles is a high priority and is a high factor in the success of the ensemble. In addition, many schools have rules that a student cannot participate in a school performance or activity if they are absent from school on the same day. A strong music ensemble program could have a positive effect on class attendance record and overall school attitude. In the model shown in Figure 5.15, students' GPA, musical background,

Figure 5.15. Ancillary Research Model: Attendance in Music (AIM) Survey

Problem: Does participation in school music ensembles have a positive effect on school attitude as measured by attendance?

Hypotheses: (1) Participation in school music ensembles is positively correlated to attendance; (2) There is a positive relationship between family music activities (FAM), other school activities and GPA.

Research Design: N=200: 200 high school seniors chosen at random from a selected area.

Methods: (1)Record percent of attendance during high school years, 9-12.
(2)Complete AIM survey instrument which indexes musical activities.
(3) Also record other activities such as sports, students government, drama, etc.
(4) Record grade point average.
(4) Complete FAM questionnaires.
(5) Analyze differences between music participation and % of attendance.
(6) Analyze relationships among other variables describing school activities, GPA, and FAM.

other school activities, and percent of attendance are collected on an attendance in music survey (see Figure 5.16). Also family background would be gathered on the family activities in music survey (see FAM, Figure 5.10, p.127).

Figure 5.16. Activity in Music (AIM) Survey

What is your cumulative grade point average?
What are your plans after graduation?
Are you planning a career in music?
Have you taken any private music lessons? What instrument(s)? How many years?
List your participation in school choral ensembles, grades 9-12. How many years?
List your participation in school instrumental ensembles, grades 9-12. How many years?
Are you involved in any community music activities? Please list activities; years of involvement; current involvement.
List your participation in other school activities in grades 9-12 (examples: sports, theatre, forensics, student government, etc.). Type of activity? How many years?
[to be completed by the tester] MAP Score: % of Attendance

Summary

In review, there were two overriding goals for this project: (1) to investigate which structuring devices in music best promote and enable chunking in the memory and performance of music; and (2) to provide a profile showing the impact of a variety of experiences in one's previous musical background on the automatic memory mechanism of chunking. Although the treatments in the intervention stage did not significantly effect chunking ability, an analysis of the effect of musical background offered conclusions and implications for both objectives. Participation in junior high and high school ensembles has the most impact on one's ability to memorize and recall melodic phrases. In this data set, in fact, the effect of band, orchestra, and choir have a greater impact than years of private lessons or even private piano study. These findings tend to support the hypothesis that a rich musical context enhances musical memory and performance. Music ensemble experiences can be considered analogous to a holistic musical environment because the performer is surrounded by a melodic, rhythmic, and harmonic context in the course of the ensemble rehearsal. Therefore, it may be inferred that musical perception as manifested by aural musicianship skills is developed best in students who are exposed to holistic musical environments. In conclusion, this musical application of memory research and chunking to the teaching and learning of music offers some fresh insight about how we remember and recall musical data.

APPENDICES

APPENDIX A

TABLES 4.30-4.42. CONTINGENCY TABLES AND ANOVAS

Table 4.30. Contingency Table – MRH and Private Lessons (1 yr. or more)

	NO	YES	Totals
MRH	4 (1.5)	14 (16.5)	18
OTHER	1 (3.5)	41 (38.5)	42
Totals	5	55	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	6.5	p=.01 **

**Significant at 1%

Table 4.31. Contingency Table – MRH and Piano Lessons (1 yr. or more)

	NO	YES	Totals
MRH	14 (7.5)	4 (10.5)	18
OTHER	21 (24.5)	21 (17.5)	42
Totals	35	25	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4	p=.04 *

*Significant at 5%

**Table 4.32. Contingency Table –
MRH and Participation in Instrumental Ensembles (InE)**

	NO	YES	Totals
MRH	4 (1.2)	14 (16.8)	18
OTHER	0 (2.8)	42 (39.2)	42
Totals	4	56	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	10	p=.001***

***Significant at .1%

**Table 4.33. Contingency Table –
MRH and Participation in Choral and Instrumental Ensembles (CIE)**

	NO	YES	Totals
MRH	12 (8.4)	6 (9.6)	18
OTHER	16 (19.6)	26 (22.4)	42
Totals	28	32	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4.1	p=.04 *

*Significant at 5%

Table 4.34. Contingency Table – M and Participation in Choral and Instrumental Ensembles (CIE)

	NO	YES	Totals
M	2 (6.1)	11 (6.9)	13
OTHER	26 (21.9)	21 (25)	47
Totals	28	32	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	6.5	p=.03 *

*Significant at 5%

Table 4.35. Contingency Table – M and Participation in Choral Ensembles (ChE)

	NO	YES	Totals
M	2 (5.4)	11 (7.6)	13
OTHER	23 (19.6)	24 (27.4)	47
Totals	25	35	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4.7	p=.03 *

*Significant at 5%

Table 4.36. Contingency Table – Piano Lessons (Pia) and Private Lessons (Lsn) (1 yr. or more)

	LESSONS	NO	Totals
PIANO	25 (22.9)	0 (2.1)	25
NO	30 (32.1)	5 (2.9)	35
Totals	55	5	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	3.5	p=.048 *

*Significant at 5%

Table 4.37. Contingency Table – Participation in Instr. Ens. (InE) and Participation in Jazz Ens. (JzE)

	JzE	NO	Totals
InE	29 (27.1)	27 (28.9)	56
NO	0 (1.9)	4 (2.1)	4
Totals	29	31	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4.1	p=.04 *

*Significant at 5%

Table 4.38. Contingency Table –
Partic. in Choral & Instr. Ens. (CIE), and Partic. in Instr. Ens. (InE)

	InE	NO	Totals
CIE	32 (29.9)	0 (2.1)	32
NO	24 (26.1)	4 (1.9)	28
Totals	56	4	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4.9	p=.03 *

*Significant at 5%

Table 4.39. Contingency Table –
Partic. Choral & Instr. Ens. (CIE) and Partic. in Choral Ens. (ChE)

	ChE	NO	Totals
CIE	32 (18.7)	0 (13.3)	4
NO	3 (16.3)	25 (11.7)	56
Totals	35	25	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4.9	p=.0001***

***Significant at .1%

Table 4.40. Contingency Table – Gender (Fem) and Participation in Choral Ens. (ChE)

	ChE	NO	Totals
Female	**21** (16.9)	**8** (12.1)	29
Male	**14** (18.1)	**17** (12.9)	31
Totals	35	25	60

CHI-SQUARE: Observed Frequency Table
(Expected Values - in Parentheses)

Summary Statistics

Degrees of Freedom	1	
Total Chi-Square:	4.6	p=.03 *

*Significant at 5%

Table 4.41 Analysis of Variance – Participation in Choral Ensembles (ChE) and Attendance

Partic. in ChE:	Count:	Mean:	Std. Dev.
YES	35	78 %	14
NO	25	69 %	17

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	1	1069	1069	4.4
Within groups	58	14033	242	p=.04 *
Total	59	15102		

*Significant at 5%

Table 4.42. Analysis of Variance – Participation in Choral and Instrumental Ensembles (CIE) and Attendance

Partic. in CIE:	Count:	Mean:	Std. Dev.
YES	32	78 %	14
NO	28	69 %	17

Source:	Degrees of Freedom:	Sum Squares:	Mean Square:	F-test:
Between groups	1	1311	1311	5.5
Within groups	58	13791	238	p=.02 *
Total	59	15102		

*Significant at 5%

APPENDIX B

TABLES 4.43-4.44. ANCOVA

Table 4.43. ANCOVA, Interaction Analysis

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.78	.74	9.64

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	8	16500	2063	22.21
RESIDUAL	51	4737	93	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	13.97			
Prt	Pretest scores	.87	.10	8.90	.000***
MRH	Melody,rhythm,&harmony trt.grp.	1.45	8.82	.16	.87
MR	Melody with rhythm trt. grp.	1.03	4.92	.21	.83
M	Melody only treatmt. group	-7.25	7.85	.92	.36
CIE	Partic. in both choral & instr.ens.	5.95	3.77	1.58	.12
Int'act	MRH x Prt	-.07	.20	.33	.74
Int'act	MRH x CIE	-2.97	6.12	.48	.63
Int'act	M x CIE	4.34	8.32	.52	.60

† at least one year participation in high school ensembles
***Significant at .1%

Table 4.44. ANCOVA - Treatment Only

Degrees of Freedom:	R-squared:	Adjusted R-squared:	Std. Error
59	.76	.74	9.73

Analysis of Variance Table

Source:	DF:	Sum Squares:	Mean Square:	F-test
REGRESSION	4	16029	4007	42.32
RESIDUAL	55	5208	95	p=.0001
TOTAL	59	21237		

Beta Coefficient Table

Parameter:	Description:	Value:	Std.Error:	t-Value:	Probability:
	INTERCEPT	18.0			
Prt	Pretest scores	.87	.10	8.90	.000***
MRH	Melody,rhythm,&harmony trt.grp	-3.01	4.96	.62	.54
MR	Melody with rhythm trt. grp.	-.51	4.54	.11	.91
M	Melody only treatmt. group	-2.53	4.13	.61	.54

† at least one year participation in high school ensembles
***Significant at .1%

APPENDIX C

FIGURE 4.9. REGRESSION LINE

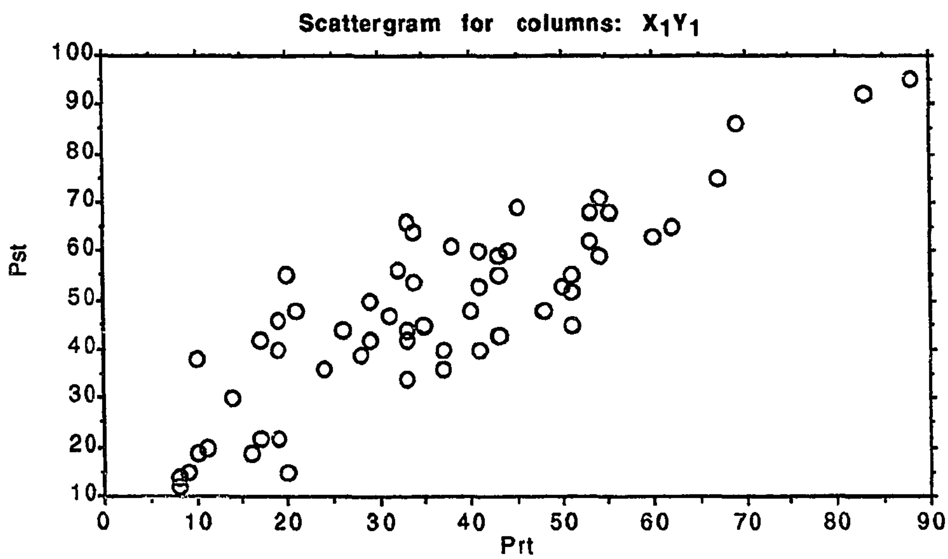

Figure 4.9. Scattergram Showing Relationship of Pretest Scores (Prt) and Posttest Scores (Pst) as Noted in Multiple Regression Analysis in Table 4.44

APPENDIX D

CHUNKING TREATMENT TAPES: SCRIPT

Tape Script

The purpose of this training tape is to develop skills in aural musicianship by imitating melodic patterns based on primary chords in major and minor tonalities. This tape is easy to use. First you will hear a short melodic introduction, then you will hear a sequence of melodic patterns. Your task is to imitate each melodic pattern on the keyboard right after you hear it, and in the same time-frame. You will be given the starting tone of the first pattern in every sequence. You may imitate the pattern at any octave and with either the right or the left hand. Each tape is approximately 10 minutes long. You will have an opportunity to practice each tape three times before moving on to the next set of sequences.

Tape 1

This is TAPE 1; SET A, melodic patterns composed of the
1ST, 2ND, 3RD, 4TH, & 5TH degrees of the C-MAJOR scale.
The starting tone of the first pattern is C.

This is TAPE 1; SET B, melodic patterns composed of the
1ST, 2ND, 3RD, 4TH, & 5TH degrees of the A-MINOR scale.
The starting tone of the first pattern is A.

This is TAPE 1; SET C, melodic patterns composed of the
1ST, 3RD,& 5TH degrees of the C-MAJOR scale.
The starting tone of the first pattern is C.

This is TAPE 1; SET D, melodic patterns composed of the
1ST, 3RD,& 5TH degrees of the A-MINOR scale.
The starting tone of the first pattern is A.

This is TAPE 1; SET E, melodic patterns composed of the
7TH, 1ST, 2ND, 3RD, & 4TH degrees of the C-MAJOR scale.
The starting tone of the first pattern is C.

Tape 2

This is TAPE 2; SET A, melodic patterns composed of the 1ST, 3RD,& 5TH degrees of the C-MAJOR scale. The starting tone of the first pattern is C.

This is TAPE 2; SET B, melodic patterns composed of the 1ST, 3RD,& 5TH degrees of the C-MAJOR scale. The starting tone of the first pattern is E.

This is TAPE 2; SET C, melodic patterns composed of the 1ST, 3RD,& 5TH degrees of the C-MAJOR scale. The starting tone of the first pattern is G.

This is TAPE 2; SET D, melodic patterns composed of the 1ST, 3RD,& 5TH degrees of the A-MINOR scale. The starting tone of the first pattern is A.

This is TAPE 2; SET E, melodic patterns composed of the 1ST, 3RD,& 5TH degrees of the A-MINOR scale. The starting tone of the first pattern is C.

This is TAPE 2; SET F, melodic patterns composed of the 1ST, 3RD,& 5TH degrees of the A-MINOR scale. The starting tone of the first pattern is E.

Tape 3

This is TAPE 3; SET A, melodic patterns composed of the 7TH, 1ST, 2ND, 3RD,& 4TH degrees of the C-MAJOR scale. The starting tone of the first pattern is B.

This is TAPE 3; SET B, melodic patterns composed of the 1ST, 2ND, 3RD, 4TH & 7TH degrees of the C-MAJOR scale. The starting tone of the first pattern is D.

This is TAPE 3; SET C, melodic patterns composed of the 1ST, 2ND, 3RD, 4TH & 7TH degrees of the C-MAJOR scale. The starting tone of the first pattern is F.

This is TAPE 3; SET D, melodic patterns from the harmonic progression C-MAJOR, F-MAJOR, G7, C-MAJOR. Ascending melodic patterns are composed of the tones of the C-MAJOR scale. The starting tone of the first pattern is C.

This is TAPE 3; SET E, melodic patterns from the harmonic progression A-MINOR, D-MINOR, E7, A-MINOR. Ascending melodic patterns are composed of the tones of the A-MINOR scale, harmonic form and melodic form. The starting tone of the first pattern is A.

Tape 4

This is TAPE 4; SET A, melodic patterns from the harmonic progression C-MAJOR, F-MAJOR, B-DIMINISHED, E-MINOR, A-MINOR, D-MINOR, G7, C-MAJOR. Ascending melodic patterns are composed of the tones of the C-MAJOR scale. The starting tone of the first pattern is C.

This is TAPE 4; SET B, melodic patterns from the harmonic progression C-MAJOR, F-MAJOR, B-DIMINISHED, E-MINOR, A-MINOR, D-MINOR, G7, C-MAJOR. Ascending melodic patterns are composed of the tones of the C-MAJOR scale. The starting tone of the first pattern is C.

This is TAPE 4; SET C, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the major scale, and the MAJOR triad built on the 1ST degree of the major scale. The starting tone of the first pattern is G.

This is TAPE 4; SET D, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the major scale, and the MAJOR triad built on the 1ST degree of the major scale. The starting tone of the first pattern is G.

This is TAPE 4; SET E, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the major scale, and the MAJOR triad built on the 1ST degree of the major scale. The starting tone of the first pattern is G.

Tape 5

This is TAPE 5; SET A-E, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the major scale, and the MAJOR triad built on the 1ST degree of the major scale. The starting tone of the first pattern is G.

This is TAPE 5; SET B.
The starting tone of the first pattern is G.

This is TAPE 5; SET C.
The starting tone of the first pattern is G.

This is TAPE 5; SET D.
The starting tone of the first pattern is G.

This is TAPE 5; SET E.
The starting tone of the first pattern is G.

Tape 6

This is TAPE 6; SET A-E, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the major scale, and the MAJOR triad built on the 1ST degree of the major scale.
The starting tone of the first pattern is G.

This is TAPE 6; SET B.
The starting tone of the first pattern is G.

This is TAPE 6; SET C.
The starting tone of the first pattern is G.

This is TAPE 6; SET D.
The starting tone of the first pattern is G.

This is TAPE 6; SET E.
The starting tone of the first pattern is G.

Tape 7

This is TAPE 7; SET A-D, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the MINOR scale, and the MINOR triad built on the 1ST degree of the MINOR scale.

This is TAPE 7; SET A. The scale form is MELODIC minor.
The starting tone of the first pattern is E.

This is TAPE 7; SET B. The scale form is HARMONIC minor.
The starting tone of the first pattern is E.

This is TAPE 7; SET C. The scale form is MELODIC minor.
The starting tone of the first pattern is E.

This is TAPE 7; SET D. The scale form is HARMONIC minor.
The starting tone of the first pattern is E.

Tape 8

This is TAPE 8; SET A-E, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the MINOR scale, and the MINOR triad built on the 1ST degree of the MINOR scale.

This is TAPE 8; SET A. The scale form is MELODIC minor.
The starting tone of the first pattern is E.

This is TAPE 8; SET B. The scale form is HARMONIC minor.
The starting tone of the first pattern is E.

This is TAPE 8; SET C. The scale form is MELODIC minor.
The starting tone of the first pattern is E.

This is TAPE 8; SET D. The scale form is HARMONIC minor.
The starting tone of the first pattern is E.

This is TAPE 8; SET E.
The starting tone of the first pattern is E.

Tape 9

This is TAPE 9; SETS A-E, melodic patterns in all keys derived from the harmonic relationship between the DOMINANT 7TH chord built on the 5TH degree of the MINOR scale, and the MINOR triad built on the 1ST degree of the MINOR scale.

This is TAPE 9; SET A.
The starting tone of the first pattern is E.

This is TAPE 9; SET B.
The starting tone of the first pattern is E.

This is TAPE 9; SET C.
The starting tone of the first pattern is E.

This is TAPE 9; SET D.
The starting tone of the first pattern is E.

This is TAPE 9; SET E.
The starting tone of the first pattern is E.

Tape 10

This is TAPE 10; SETS A-D, melodic patterns in all keys derived from the harmonic relationship between the MAJOR triad built on the 1ST degree of the MAJOR scale, and the MAJOR triad built on the 4TH degree of the MAJOR scale.

This is TAPE 10; SET A.
The starting tone of the first pattern is C.

This is TAPE 10; SET B.
The starting tone of the first pattern is C.

This is TAPE 10; SET C.
The starting tone of the first pattern is C.

This is TAPE 10; SET D.
The starting tone of the first pattern is C.

Tape 11

This is TAPE 11; SETS A-E, melodic patterns in all keys derived from the harmonic relationship between the MAJOR triad built on the 1ST degree of the MAJOR scale, and the MAJOR triad built on the 4TH degree of the MAJOR scale.

This is TAPE 11; SET A.
The starting tone of the first pattern is C.

This is TAPE 11; SET B.
The starting tone of the first pattern is C.

This is TAPE 11; SET C.
The starting tone of the first pattern is C.

This is TAPE 11; SET D.
The starting tone of the first pattern is C.

This is TAPE 11; SET E.
The starting tone of the first pattern is C.

Tape 12

This is TAPE 12; SETS A-E, melodic patterns in all keys derived from the harmonic relationship between the MINOR triad built on the 1ST degree of the MINOR scale, and the MINOR triad built on the 4TH degree of the MINOR scale.

This is TAPE 12; SET A.
The starting tone of the first pattern is A.

This is TAPE 12; SET B.
The starting tone of the first pattern is A.

This is TAPE 12; SET C.
The starting tone of the first pattern is A.

This is TAPE 12; SET D.
The starting tone of the first pattern is A.

This is TAPE 12; SET E.
In this sequence, both the harmonic and melodic forms of the minor scale are used.
The starting tone of the first pattern is A.

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