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Improving instrumental practice techniques through use of a motor schema theory of learning

Owen, John Edward, Ph.D.
The Ohio State University, 1988

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IMPROVING INSTRUMENTAL PRACTICE TECHNIQUES THROUGH USE OF A MOTOR SCHEMA THEORY OF LEARNING

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
John Edward Owen, B.M.E., M.M.

**********

The Ohio State University
1988

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School of Music
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CHAPTER I
INTRODUCTION

It has been recognized that proper practice is extremely important in the achievement of musical performance skills. Zurcher (1972) writes: "The need for young musicians to learn proper practice procedures in order to make results commensurate with time spent in practice should be a primary concern for all music educators" (p. 132).

Practice facilitates the learning of the requisite physical and motor skills necessary for performance on a musical instrument. Despite the importance of practice, instruction in efficient methods of practice varies widely, according to the background of the musician. Numerous authorities have cited the need for improved understanding of the process of practicing, including Madsen, Greer, and Madsen (1975), Ross (1985), and Wagner (1975).

This study examines traditional methods of practicing in comparison with a method based on a motor schema theory of learning.

Motor Schema Theory
According to LaBerge (1981), the brain utilizes schema, which can be defined as a rather small set of generalized stored movements from which a larger, more specific set of movements can be drawn (p. 183). Thus, the brain need not store the specific and detailed instructions for every possible motor and muscle movement
needed for the execution of a complex task. Rather, what is stored is an abstract representation of a movement, and the possible consequences to it. The actual movement is seen as an interaction between the schema and the environment of the moment.

However, the manner in which these generalized movements are translated into actual motor movement is unclear, and extremely difficult to test. LaBerge proposes a second level of memory storage which he terms "coordinative structures" (p. 184).

These structures store the information necessary to turn the general commands from the executive level, where they may be stored, into concrete movement. In addition, it appears that these structures can institute movement by themselves in response to kinesthetric feedback in some instances.

Thus, a rough picture begins to emerge. When learning a new motor skill, the coordinative structures are, in effect, being programmed. Specific muscle movements are stored there, and an abstract, much more general set of movements is stored at the executive level. Interaction between the two levels, and incorporating feedback from the environment, results in the final motor act. In music learning, an illustration can be drawn from reading notation and then producing a sound on an instrument. In the initial stages of the learning, a large variety of small movement is programmed into the so-called lower levels, or coordinative structures. Some of these might be holding the instrument correctly, placing it against the mouth, pressing the correct valves or keys, forming an embouchure, blowing pressurized air into the instrument, and many more movements. (It can be readily seen that each of these examples, in turn, also requires several smaller movements.) Eventually an abstract pattern becomes stored
at the executive level. When reading a given note, the performer does not think about each individual part of performing that note. Rather, the command is issued to the coordinative structures, which in turn produce the movements necessary to produce the pitch. The kinesthetic feedback produced by the instrument and the surrounding environment is also connected with this. When everything functions properly, the desired pitch results. However, if one part of the sequence is executed improperly, then the possibility of error is introduced.

Another musical example of the interaction between the executive level and the coordinative structures can be seen in the learning and performance of a musical scale. In the early stages, the scale is learned a single note at a time, along with its fingering. Eventually, the notes become linked together in a more abstract form which could simply be called "scale". When an experienced performer encounters the scale in printed music, the executive level may furnish the abstract concept of scale to the coordinative structures, where the specific set of movements necessary to perform the scale have been stored. It is not necessary for the performer to think of the notes of the scale individually and how to produce them, since that information is stored at a different level.

In time, small units stored at the coordinative structures can be combined into larger ones in a hierarchical fashion. A note can become a pattern, a pattern becomes a phrase, a phrase becomes a section, a section becomes an entire work, and so into larger and larger units when dealing with very experienced performers. During performance, the musician does not think about the small units, but rather of the large ones, and the previously stored information provides the necessary movements. Thus, the executive level becomes concerned
more with musical decisions, and less with physical and motor ones. According to LaBerge:

A key assumption in the elaborated schema theory is that acquisition of a performance skill involves development of structures at two main levels. At the lower level the automatic reflex-like muscle movements are carried out by acquired coordinative structures. At the higher level, the voluntary motor conceptualizations are organized as motor schemas. (p. 186)

During the learning and practice process, the performer moves gradually up the hierarchy as a piece of music is learned or memorized. In the latter stages of practice, it is likely that the performance is largely controlled by the executive level, acting on stimuli from various sources. These include the environment, the thought process and aesthetic feel of the performer, the kinesthetic response of the player to the instrument, and others. Sometimes in performance, however, the performer returns to a lower level, thinking perhaps of executing a difficult technical maneuver, becoming suddenly aware of the setting or the audience, or focusing on the music in a different way than has been done in the practice period. When this happens, the likely result is a misfit: the information and feedback being received do not match the links between the various levels of structure established in learning. This then can result in disorientation, until the entire structure is disconnected, resulting in memory loss, or in confusion until a familiar pattern can be connected, and the piece can proceed as prepared. This misfit can be the result of changed setting, of nervousness, of a sudden shift in concentration, or an unfamiliar response. There should be some provision made during the practice periods to allow for these differences, and teachers could assist students in identifying likely problems during the
practice portions of preparation.

These misfits, according to LaBerge, tend to occur at boundary points within the music, such as the end of a phrase (p. 187). Also, a hesitation in moving on to the next section might occur at a similar point in the musical flow.

This example also might well illustrate the two types of features which are apparently part of the connection between the executive and the coordinative levels. The first feature is global information, which feeds the executive level. Global features are those which generally pertain to more than two elements. Examples of global elements might be the phrase, the direction of a melody, the general harmonic background, or aesthetic responses to particular sections of a piece of music.

Local features are those having more often to do with a single element, including the interval between two notes, relative levels of dynamics or accent between notes, the type and length of articulation used on a note, and most things having to do with the immediate production of a sound isolated from its overall context.

Interestingly, it appears that different links between the levels occur depending on the stimuli present. For example, either describing or visualizing a phrase in a number of different ways will cause the implementation of different coordinative structures, resulting in differing performance. Since these stimuli are not always under the control of the performer, they can produce unexpected results in performance.

Some implications for the teaching and effective practicing of performance abilities in music can be drawn from this theory of motor schema and coordinative structures. If the theory is correct, then some possible conclusions based on it might be as follows:
1. Learning motor skills in music performance proceeds from smaller to ever larger units. In musical practice, links should be sought to connect smaller segments to larger.
2. Since the coordinative structures are, in effect, programmed during practice, ineffective or incorrect practice can build poor or incorrect motor responses. These might then be difficult to erase or extinguish.
3. For greatest efficiency, a plan of practice might be used, attempting to maximize the building of coordinative structures, and the bonding into larger units.
4. While practicing, information is being stored at both the local and global levels.
5. Since different verbal cues or ways of thinking about a given musical segment seem to use different coordinative structures, and yield a different response, then attempts should be made to build many links based on different stimuli.
6. If misfits tend to occur at joints between various sections (such as phrase endings), then attempts should be made to build structures which also bridge these points.
7. The efficient and productive use of practice time depends on an understanding of, and instruction in, the methods by which skills are obtained.

Traditional Methods of Practice

A review of the literature has identified traditional methods of practice. For the purposes of this study, these traditional methods were regarded as being based on the description of efficient musical learning as described by Leonhard and House (1959). Others who have identified
methods of practice include Allgood (1983), Blum (1982),

These traditional methods are based in problem-solving,
and utilize a variety of techniques. Some of these
techniques include slow practice, the establishment of
goals for practice, mental practice, and practice planning.

For the purpose of this study, a traditional method of
practice was employed by a selected group of participants
in order to permit comparison and contrast with the motor
schema theory. This traditional method is described on the
following pages.

Establishing a Format for Proper Practice

Students sometimes do not understand how and what they
should be practicing. It would seem logical to structure
practice time in the most efficient way to facilitate
musical and motor learning. According to Leonhard and
House (1959), the most efficient steps to musical learning
may be stated as: (a) an aural concept of what is to be
achieved; (b) provisional tries; (c) reflection on what is
right and what is wrong; and (d) a decision on what changes
should be made in the next tries (p. 134).

In more concrete form, this could be expressed through
a four-step process. The four steps are: (a) recognition
that a problem exists; (b) isolation of, and work on, the
problem; (c) insertion of the problem back into the larger
context of the selection; and (d) reevaluation. These four
steps, derived from Leonhard and House's description of the
most efficient steps to musical learning, can then be
developed into a format for practice.

Based on these steps, then, an established practice
format could consist of a method of identifying problems in
performance, and methods for building the coordinative
structures to deal with the necessary motor skills. These
would be linked with a structure at the executive level to allow adequate performance of the chosen selections.

The following steps could serve as a model for establishing practice format. They are derived from Leonhard and House (1959), and from Kohut (1973, pp. 185-190). For the purposes of this study, these steps were regarded as representing traditional methods in the teaching of practice technique. While it is clear that use of these steps could facilitate the development of schema to some extent, there is no emphasis on recognition of schema formation or awareness that the schema exist.

Identifying the Problem

The identification of a performance problem should be viewed not only as recognizing a place where errors have been made, but also any area in which the performer desires to improve performance skills. The identification of a problem can be internal, coming from the performer, or external, being suggested by another person or by mechanical means. Whatever the source, when seeking to identify a problem, the performer might begin by simply reading or playing through the selection in question, or choosing material which emphasizes the skill which is to be acquired, doing so slowly and without undue regard for errors which might occur, except to note where and when they occur.

There appears to be no data to suggest how much simple reading can take place before structures begin to build, thus reinforcing correct or incorrect performance. However, this writer suggests two initial readings during the identification process in order to eliminate the element of chance, and to minimize reading errors.

Following the second reading, the student should mark passages and technical problems which need further work.
This allows for the separation of difficult or problematic passages from those which will require less attention. The latter should then be put aside for later study.

The effectiveness of identification is necessarily limited by the performer's prior experience and knowledge. It is suggested, therefore, that the teacher or an outside source assist in problem identification, making specific references and assignments, and providing a later time for the reevaluation of problem areas. As students gain experience, they will improve the ability to recognize problems quickly, with reinforcement from outside sources.

Isolating the Problem

Having identified a given problem, the student must next discover the actual difficulty within it, and implement a strategy for correction. For most problems of technique, it seems likely that the necessary motor skills and/or connective structures have not been adequately learned. Thus, it might be necessary to begin with very small units, perhaps of two or three notes, slowly building both the motor and aural skills to play with correct fingerings and the proper rhythm, even if at a slow tempo. As these notes are learned, the musician should gradually add new ones, taking care to practice making connections between new notes learned and those previously stored, thus building larger connections. If a problem does not respond to repeated attempts when playing it from the beginning of the section, the student might try it from the center, or from the end and work backward. In this way, more than one set of structures will be constructed. Some passages might contain more than one difficulty; if so, each should be approached separately. According to Blum (1982), the sequence is to begin with simple, isolated tasks, and
proceed step by step toward gradually more complex ones (pp. 4-5).

Rather than simply repeat the designated material over and over, it is suggested that the student spend amounts of time playing, silently fingering with the instrument while forming an aural image of the material, or analyzing the difficulty. In this way, more global information might be stored, and more connective links between the levels can be established. Also suggested are exercises such as changing the rhythm, articulation, and dynamic levels of the material, likewise to maximize both local and global functions while practicing. Supplementary exercises which use a similar pattern of motor function could also be used.

Once the problem has reached a satisfactory level at the slower tempos, the performer should gradually attempt to increase the tempo toward the desired point. It is important to realize that it is unnecessary to achieve a high level of performance on the early attempts. Rather, emphasize the building of speed to allow the attainment of the desired skills.

Inserting the Problem into the Original Context

The next step is to reinsert the extracted problem into a larger context, such as the connecting phrases, or into an entire section of a musical piece. It will probably be necessary to also practice the transitions to and from the problem which was identified, since no structures have been formed to cover these. Methods similar to those given previously may be used to accomplish this. Each problem area which was originally identified should be worked through in a similar fashion. Performers will sometimes be surprised to discover that a problem which was assumed to be "learned" on one day will require further attention in later practice sessions. It is necessary to reinforce
regularly the skills which are being learned to prevent their extinction. It must be stressed that review is essential to good practice routine. The review may be approached in a similar fashion to the original problem, but should yield more quickly to repeated practice, since some coordinative structures have been already established. It should also be helpful to remind the advanced performer to carefully analyze the pattern which has been practiced, so that similar patterns encountered in the future will be quickly recognized, utilizing the schemata being developed.

Reevaluation

After all designated problem areas have been resolved, the entire piece or segment should then be played. It might be then discovered that new difficulties have arisen which were not apparent earlier. These should then be subject to careful practice, until several different sets of schemata and the attendant coordinative structures are in place, thus insuring the learning on a number of levels, and promoting the chances of successful performance. With concentrated practice, and over a period of time, a considerable variety of applicable schemata can be formed. According to Gagne (1977): "Clearly the difference between the experts and novices does not lie in the quality of reasoning they exhibit . . . . The advantage to the expert . . . lies in the sets of rich schemata that are relevant to the problem and its interpretation" (p. 187).

In summing up the four-step process of practicing, Kohut (1973) has a succinct and seemingly accurate comment:

success or lack of it will be measured by his ability in evaluating properly the musical results achieved in the practice room; identifying the underlying reasons for failing to achieve those results; woodshedding the "hard spots" along with study of appropriate technical
studies or exercises as needed; and finally going back to the real music and re-evaluating the overall musical results. (p. 186)

**Concepts for Practicing**

In addition to utilizing proper practice format, it is important to be certain that students have proper concepts about the methods of practice, and well-formulated plans for both short range and long range goals. Once again, this methodology can be seen to have relationships with the schema theory.

One of the important tools for efficient learning is slow practice. Yet, it is difficult and sometimes unpleasant to use, requiring a good deal of self-discipline to be effective. There are several well-founded reasons for using slow practice, the most important of which is to allow the formation of the desired coordinative structures.

It has been recognized that undue tension is undesirable in instrumental music performance, and slow practice can be an aid in relaxing tension, since it allows adequate time for reading, for reflection, for utilizing techniques previously learned, and allows the formation of the structures desired which can be then utilized in performance (Kohut, 1975, p. 187). In slower motion, the hands, arms, fingers, throat and chest can all be more relaxed, due to lessened demands upon them to respond quickly and under pressure of failure. In addition, playing more slowly might make the material seem easier, which has a positive effect on the mental outlook of the performer. In short, if ample time is allowed when in the early stages of learning, it is far more likely that a relaxed, natural, and musical performance will result, due to the correct and positive connections learned.

In the long run, however, it is not sufficient to merely analyze and solve problems which occur daily. For steady
and consistent improvement, a long range plan of practice is important with short range goals being formulated to lead toward the longer plans. Short range goals may be thought of on a daily basis, with long range goals covering a month, semester, year, or longer for more advanced students. The type of goal, and the length of time in which the goal would be in effect, would vary according to the level of advancement of the student.

In order to make the most efficient use of time, the student should schedule practice sessions at a time which is relaxed and comfortable, preferably at a consistent time each day. Research shows that more is achieved with a number of shorter practice sessions than with one longer, extended session which covers the same amount of time (Duerksen, 1972, p. 13).

The extended practice plan should include the examination of the music, the initial practice time, a time for review and mental practice of the material, and then more physical practice, possibly in a different session. This could easily be stretched to extend over several days, or multiple sessions in the same day.

The value of mental practice has been shown in many studies, including a considerable number done in the field of physical education. Citing a number of sources as evidence, Drowatzky (1975) gave three guidelines for mental practice:

1. The learner must have some prior experience with the task or a similar one before mental practice will improve performance.
2. Persons with higher skill levels will benefit more from mental practice than beginners.
3. A combination of mental and physical practice may be more effective than mental practice alone. (pp. 222-223)

Technical passages, phrasing, memorization, tonguing, and other musical aspects are all good subjects for mental practice, and can be done during periods of the day when the student is otherwise not occupied in musically useful behavior. For example, the time spent in riding the bus, walking to and from class, sitting in study hall, or while resting during rehearsal can be put to use by using the mind to practice difficult technical and musical challenges, and make the time spent with the instrument more productive.

Students should also form a definite routine for practice. Included might be such elements as: (a) warm-up; (b) slurring, including extensions in range; (c) interval work for technique and ear training; (d) scales and technical studies in varying rhythms, rotating scales so that all are eventually covered; and (e) the main practice period, covering literature and designated studies. In developing such a routine, the student will spend some time each day developing a wide series of coordinative structures, available for use when needed musically. In so doing, the student will certainly increase the speed of learning when called upon to approach unfamiliar music.

Duerksen writes that there is no apparent benefit to extremely repetitive drill, known as the concept of overlearning (Duerksen, 1972). A possible way to better utilize time available might be through a combination of physical and mental practice, guided by both long and short range goals for improvement.
The Problem

This study was undertaken to address the problem of a lack of research-based knowledge concerning effective methods of musical practicing. Various writers, including Ross (1985), Madsen and Geringer (1981), Wagner (1975), and Zurcher (1972), have documented the need for more concrete knowledge in the area of musical practice.

More specifically, this study recognized the possibility that musicians might not know the most efficient methods of musical practice, and sought to determine the effectiveness of two specified treatments in increasing practice efficiency.

Purpose of the Study

The purpose of this study was to determine whether a motor schema approach to musical learning could be applied to increasing efficiency in musical practice. This approach was based on the motor schema theory of learning as described by LaBerge (1981). The group receiving this instruction was designated the Motor Schema Theory Group (MST).

A secondary purpose was to measure the progress of two other groups as compared to that modeled on LaBerge's principles. These groups were: the Traditional Group (TG), based on the practice format previously presented (pp. 7-14) which was derived from Leonhard and House (1959) and Kohut (1973), and the Control Group (CG), a no-contact group.

The Hypothesis

This study began with a hypothesis concerning the use of the motor schema theory in improving the practice techniques of instrumental musicians. The hypothesis can be stated as: It is believed that instruction in practice
technique based on the motor schema theory of learning will produce significant differences between the scores of the experimental and control groups, as determined through tests of musical performance.

The null hypothesis for the study can be stated as follows: It is believed that instruction in practice technique based on the motor schema theory of learning will produce no significant differences in the scores of the experimental and control groups, as determined through tests of musical performance.

The Need for the Study

Although there have been many articles written concerning methods of practice, the great majority of them are based on anecdotal experience, rather than on the results of planned research. There can be little doubt that the ability to practice effectively is an important skill for musicians of various ability levels, and that there are many ways to go about organizing this practice. There would seem to be a clear need for studies which address themselves to determining the relative effectiveness of various methods of practicing. Madsen and Geringer (1981) wrote:

Several considerations concerning effective practice need to be investigated in order to determine effective procedures. It would seem that there are three general considerations regarding practice: 1) amount of time spent, 2) the degree of attentiveness, and 3) selectivity of effective procedures. (p. 46)

This study addressed the third of these considerations.

It is generally conceded that the acquisition of musical skills, including both the motor skills and psychological skills of performance, requires a degree of practice. For all musicians, there is a finite amount of
time available to do this practice; it would seem logical, then, to discover those methods which yield the most consistent results and to put them into general application in the teaching of practice behavior to those desiring to acquire musical skills. Again, Madsen and Geringer stated: "A most basic aspect of improved learning and performance would seem to be efficient use of time and the development of effective practice routines. A systematic study of music practice has not received the attention that it deserves" (p. 51).

It would seem to be clear that there is a need for research into the methods of practice, and the most efficient ways to teach practice behavior. This study addressed the perceived needs of those interested in teaching and learning efficiency in practicing.

At the completion of this study, findings might be of interest to all those involved in teaching performance aspects of music, including teachers of applied music, directors of ensembles, and school music teachers. Improved efficiency in practice is of direct benefit to both teachers and students of instrumental music.

Assumptions and Limitations

For the purposes of this study, it was assumed that all subjects being tested and receiving instruction had attained a level of proficiency on the instruments in question beyond that of beginning players. While ability levels were mixed, it was assumed that all subjects had basic skills, as determined by a pretest. It was further assumed that persons being tested were of normal physical and mental abilities, and that they possessed an interest in improving their performance levels.

This study was limited to volunteer subjects, grouped through a matching procedure in order to minimize initial
differences between the groups. For research purposes, it was limited to instrumental musicians; although results might be applicable to other areas of music, no assumptions of validity for areas other than those specified will be made. It was limited to the time period mentioned. Size of the experimental groups was limited by the number of qualifying musicians available. The type, content, and format of instruction were limited to that outlined in this paper for each of the three groups utilized for this study.

The conclusions made were based on the evidence and data collected from this study. Again, parallels could be drawn between the groups studied here and other, similar groups of differing constituency. However, the intent of this study was limited to determining the effect of a body of given instruction on the Motor Schema Group (MST) in comparison with control groups of similar musicians.

In addition, a single etude, designated as Etude A, was used for the pretest, interim tests 1 and 2, and posttest 1. Posttest 2 was limited by the use of a single etude as well, designated as Etude B.

Definitions

For this study, several definitions were used. The concept of the motor schema theory of learning was that described by David LaBerge in his paper "Perceptual and Motor Schema in the Performance of Musical Pitch" (LaBerge, 1981). Although the term "motor schema" was used throughout the study, it was understood to apply to schemata formed both for the motor acts and for the perceptual patterns which can govern them.

The terms "musician", "performer" and "participant" were considered to be synonymous in this paper. Any may be used to describe participants in the study, without
prejudice or intent to designate individuals in any way. Each of these terms was considered to include individuals with some training in performance on a musical instrument.

"Practice" was defined as a period of time spent in attempting to gain proficiency at performance on a musical instrument. It was limited to time designated for that purpose; however, practice can be physical, mental, or a combination of the two. Practice time was not interpreted as being limited to those periods spent in a given location, doing specific physical acts. Time spent in reinforcing, considering, planning, and visualizing performance skills and concepts was also considered to be part of the practice routine.

The study group (MST) was defined as those musicians receiving the designated instruction in practice behavior and formation of appropriate schema. There was a second group (CG) which received no instruction in practice technique whatever; however, other parts of the study, including pretesting and posttesting for purposes of comparison were utilized. A traditional group (TG) also functioned as a control group; this group did receive instruction in practice technique, but did not receive instruction in concepts relating to motor schema formation and use. The instruction utilized with this third group was equivalent to that received during the first three weeks of instruction to the MST Group. The purpose of this instruction was to make certain that all students in these two groups had a common level of information in practice theory which was believed to be similar to that commonly taught in applied studio lessons at the college level. The function of the traditional group was to contrast commonly used instruction with the group receiving further information in the formation and use of schema.
The three groups were selected through a matching procedure from a designated larger pool of volunteers, and assigned without regard for prior background or instruction in practice technique. All, however, did satisfy the minimum requirements for the study.
CHAPTER II
REVIEW OF RELATED RESEARCH

Research in practice methodology, mental versus physical practice, and the effects of various practice schedules on performance is extensive. However, much of this research has been done in the field of physical education, especially in relation to athletic events. While there might well be some application to this research, much of it appears to have little utility for the musician. Surprisingly, there appears to be relatively little research in the area of musical practice. Madsen and Geringer (1981) comment:

Basic questions remain regarding effective amounts of practice as well as specific shaping procedures necessary to optimize the time spent. While practice periods have traditionally been divided into sections for warm-up, scales, etudes, etc., the effectiveness of these procedures does not seem to have stimulated much investigation. . . . Clearly, procedures that prove effective in increasing attention span seem worthy of research. (p. 51)

For the purposes of this study, the review of related research will be limited to those studies which have relevance to the field of musical practice, including both mental and physical practice.

Of these, four stand out as being most closely related to the purposes of this study. Each will be briefly summarized in this chapter, along with several other studies which appear to have some degree of relevance.
The studies have been categorized as dealing with mental practice, varied practice procedures, and motor schema formation. In each category, the studies which involved musical practice were discussed first, followed by those which dealt with non-musical research.

**Mental Practice**

The most relevant research in mental practice procedures was completed by Ross in 1985. His research centered on improving the performance of college trombonists through the use of mental practice. The experiment used thirty trombonists from three different colleges; the trombonists were randomly assigned to one of five groups to test various practice conditions. The groups were: (a) all physical practice, (b) all mental practice, (c) a combination of physical and mental practice, (d) mental practice with slide movement, and (e) no practice.

According to Ross, the results of his study suggest that mental practice can be beneficial to college musicians, especially when combined with physical practice. He suggests that initial learning of music might be facilitated through a systematic approach to practice which emphasizes both mental and physical practice. In his suggestions for future research, Ross writes: "There is a need for future studies that utilize different types of instrumentalists or vocalists, experiment with various interventions of mental trials between physical trials, use different levels of music from easy to very difficult, and employ different rations of physical and mental practice trials" (p. 67).

Ross's research is clearly of merit; however, the design of the study limits the findings relative to the use of practice techniques for extended periods of time. The
The experimental portion of Ross's study was conducted in a single day. The subjects were administered a pretest which established their performance level. There was then a period of time for rest and practice which appears to be approximately one hour in length, following which the subjects were given a posttest to measure gains in their performance of the selected etude. The etude was the same in both the pretest and posttest.

A second study of interest was conducted by Wagner. In his research, he measured the results of using a written practice report on musical performance (Wagner, 1975). In this study, subjects were divided into four groups. Three of the groups received practice reports to fill out weekly, while one was designated as a no-contact group. The three groups using practice reports were assigned them for various lengths of time: one group used them for the entire eight-week duration of the study, another for four weeks, and the third for two weeks.

The results showed that all groups improved over the eight-week period. However, there were no significant differences between groups. Wagner reports: "Data indicated an inverse correlation between the using of a practice report and the amount of time practiced. . . . Obviously, further investigation is indicated" (p. 130).

A third study of interest was conducted by Zurcher (1972). In his research, he attempted to investigate the effectiveness of using cassette-recorded models and instructions for home practice relative to performance achievement. For the purposes of the experiment, selected subjects were given recorded models of selected exercises, along with written suggestions for practicing. They were then compared with a second group of subjects who did not use the recorded models. Zurcher discovered that model-supported practice was more effective than
traditional practice on the six variables which were tested. These included gross pitch discrimination, pitch matching, time spent in practice, rhythmic discrimination, and others.

The fourth study which appears to be most directly related to this study utilized a completely different approach. Through a review of the psychological and educational literature available, Horning (1982) sought to develop a model of the psychological processes which translate musical stimuli into affective and aesthetic experience. While this study does not deal with practice concepts, it does deal directly with the ways in which the mind and body process musical stimuli. As such, it would appear to have relevance to a theory such as the motor schema theory of learning.

**Additional Mental Practice Studies**

Studies in musical mental practice techniques were done by Rubin-Ralson (1941) and Lo (1976). Kemeny (1986) and Winters (1987) studied mental practice in a non-musical setting.

The study by Rubin-Ralson was an attempt to determine the effect of mental rehearsal in memorizing music. The subjects were nine pianists, divided between three groups. The three groups were instructed to vary the amount of analytical study, keyboard trials, mental practice, and then subsequent keyboard trials. Sessions were distributed over three consecutive days, with relearning tested two weeks later, and again seven months later. The writer concluded that the most productive method of the three employed was five minutes of analytical study, followed by keyboard trials, followed by four minutes of mental practice. In this procedure, the subjects were essentially following the formula of: (a) forming an aural image of the
piece; (b) attempting various trials; and (c) analyzing and mentally practicing the results of the trials. This is similar to the procedure advocated by Leonhard and House (1959).

There appear to be a number of potential problems with the Rubin-Ralson study, including the extremely small number of subjects, the lack of control on the part of the experimenter and apparent lack of random assignment to the three groups, and questions concerning the difficulty level of the music chosen. These questions obviously place the conclusions made by the experimenter in doubt.

The second study of mental practice in music was completed by Lo (1976). In this study the researcher examined the abilities of pianists to memorize music through mental rehearsal. The subjects received either two weeks of visualization training or general memorization suggestions, with the latter functioning as the control group. While no statistical significance was shown, the visualization subjects apparently improved more than the control group.

Kemeny's study involved two experiments to test the suitability of two experimental paradigms for studying the effectiveness of mental practice. Study number one showed mental practice to be effective before physical practice, but not after physical practice, or between repetitions of practice in subjects using the pursuit rotor as a motor task. The second study found that mental practice is often task-specific, and its magnitude varies considerably with different measures.

Winters conducted four experiments examining imagined rehearsal on dart-throwing performance. In this study, the researcher found no differences among groups attributable to the effects of mental practice. The writer argues that mental practice has its greatest effects at the highest
levels of motor control, and as such would have its greatest influence on elements such as motivation, attitude, and strategy.

**Varied Practice Procedures**

Several studies were also identified which appear to have some relevance, although less than those previously cited. Studies dealing with musical practice procedures were done by Manturzewska (1979), Spradling (1979), and Williams (1982). Studies involving non-musical practice procedures were by LaLance (1974), Jeffery (1974), and Nigro (1983).

Manturzewska tested competitors and winners of an annual piano competition in Poland in relation to their overall musical knowledge and achievement, overall intelligence, and personality traits. One of the questions concerned the amount of time spent and procedures used while practicing. While she found that competitors reported practicing more than students in a control group, there appeared to be no significant differences in the techniques and methods of practicing.

Spradling’s study dealt with ways to motivate students to practice. He found that practice time could be increased through the use of a practice contract. Students negotiated a contract for the amount of time they would practice over a given time period, and the specific time periods when they would practice. Students using the contract reported greater amounts of time practicing than those in a control group.

Williams examined several possible models for the retention, recall, and storage of musical events. Part of the research dealt with the ways in which pitches were stored and recalled, and the methods by which they were processed. He concludes that there might be differences in
how images are stored depending on whether they are perceived as primarily visual (the shape of a melody or phrase) or auditory (specific pitches). In relation to LaBerge's theory, these could be seen as varying schema; the performer would call on them through means of the desired perception of the image. Varying schema would result in varying images, or in varying musical representations of the work in question.

While the studies by LaLance, Jeffery, and Nigro were not directed toward musical practice, the conclusions they offered would seem to be of relevance to the present study, particularly in regard to the benefits and techniques of practice. Each of these studies involved practice of motor acts, and the acquisition of the skills necessary to perform the designated acts.

A study involving various methods of practice was reported by LaLance. His purpose was to compare the effects of traditional instruction, mental practice, and combined mental-physical practice. The subjects were tested on various methods of proficiency in handball. His conclusions were: the various methods of practice proved insignificant in some of the physical skills needed for handball. For others, the traditional instruction, which apparently involved instruction in fundamentals of handball, and trial-and-error practice, was superior to mental practice, or combined mental-physical practice. However, combined mental-physical practice was shown to yield results superior to those of a control group in which subjects received no instruction.

In a related study, Jeffery sought to determine whether subjects learned more efficiently through use of a symbolic-motor rehearsal schedule, through modeling, or through a motor-symbolic sequence. The study demonstrated that subjects who rehearsed symbolically, whether singly or
in conjunction with motor practice, were able to reproduce modeled sequences more accurately than those who rehearsed only motor acts, or did not rehearse at all. The results were said to lend validity to the view that behavior is best acquired through modeling, when activities are organized to allow first symbolic representation, and then motor skill practice. Subjects who rehearsed symbolically were said to perform better on both tasks of simple and complex organizational levels. The results of this study would seem to suggest that mental practice could be beneficial to musicians when learning motor skills, particularly early in the learning period, and that adequate time should be allowed for symbolic rehearsal and learning.

Nigro studied the improvement of skill through use of observation and mental practice. She identified two types of learning which were said to take place during the learning of a visual-motor skill. These types were: perceptual learning, in which the learner discovers the possibilities inherent in the learning situation, and coordination, in which the learner discovers how to increase efficiency and smoothness of execution in the desired task. In one experiment, she explored the effects of two variables on imagined practice in dart throwing. In this study, mental practice produced more improvement when the subjects imagined themselves in the act of throwing, rather than imagining themselves as observers of someone throwing. In a second experiment the researcher compared four different types of practice: physical, mental, observation, and imagined observation. Of these, physical practice and observation were reported beneficial to the performance of the subjects; mental practice with observation was somewhat less beneficial. However, all practice groups performed better than a control group.
Nigro suggests that imagining and observing are both viable forms of increasing perceptual coordination.

**Motor Schema Research**

In addition to the studies cited above, a number of studies have been identified as supporting the validity of the motor schema concept. Two studies which were musically based were conducted by Abe and Hoshino (1985), and Krumhansl (1983). Carson (1978), Poretta (1981), Melville (1976), and Whyte (1981) conducted studies of motor schema formation in non-musical settings.

Abe and Hoshino studied the behavior of a Western music expert (WCME) and a Japanese traditional music expert (JTME) in three-note melodies in two different experiments. The results indicated that the WCME assimilated the tone sequences in schema relative to the major and minor diatonic system of Western music, while the JTME did not. The schema-driven properties of the subjects' perception and prediction of melody were verified. This study appears to confirm the existence of schema for the processing of melodic materials; as such, it would appear to have direct relation to a portion of this study.

Krumhansl summarized recent investigations into the psychological representation of pitch relations in tonal music. She found evidence for the existence of three levels of organization in the perception of tonal music: these were musical tones, chords, and keys. She writes: "These results suggest that the listener relates the sounded elements to an abstract internal representation of the structural regularities underlying tonal music" (p. 28).

Carson conducted a study which attempted to test the formation of motor schema. A second investigation was performed to determine the retention of the motor schema
after a two-week interval. The training was done with pre-school children involving learning to toss a bean-bag. The results were said to support variability of practice in the formation of motor schema, in regard to varying the conditions and variables during the practice period. In the second investigation, the subjects using variability of practice showed significantly greater recall than those in other groups. While Carson's study is only distantly related to the current research, it does add evidence of the existence of motor schema, and the possibility of using the theory in learning motor skills.

Poretta reported research similar to Carson's. This study is relevant only in that it also supports the formation of motor schema. The subjects were educable mentally retarded and intellectually normal males. This study also showed improvement through use of a variability of practice, similar to Carson.

A study by Melville combined the concept of the motor schema with manipulation of the knowledge of results. Subjects were provided with knowledge of results during initial training for a task involving rapid movement. Later, the subjects were trained for a second task in which they were allowed no knowledge of the results. The subjects were asked to make estimates of their performance during both training sessions. Results indicate that subjects were not able to improve their performance during the training period in the absence of knowledge of results. The study was said to partially support the concept of motor schema formation. One group of subjects trained at a specific rate in the performance of the motor task. They were then shown to be equal to a second group which trained at a faster rate when both groups were tested at the faster rate. This was seen as being supportive of motor schema formation in the learning of the task, regardless of the
speed of the training.

The final study of interest to the present research was performed by Whyte. The purpose of Whyte's research was to develop a quantitative method for the study of automatization in complex skills. Automatization of complex skills with practice was accepted as a given for the purpose of the study. The researcher studied automatization through use of a motor tracking task. Conclusions of the study were that automatization is dependent both on quality of performance and on the goal of performance. This conclusion would seem to be clearly related to the design of the current research, in that it demonstrates that automatization, a feature of the executive level of LaBerge's schema theory, is dependent on two variables, each of which is addressed in the current study.

While there are certainly other studies which are of interest to this one, these cited would appear to support two conclusions. First, there is evidence of the existence of schema in the perception of musical patterns. The ways in which these function, and their uses in practical applications of learning, however, are still unclear.

Secondly, there is a need for increased research in methods of efficient practice. The relevance of studies of athletes to music applications is unclear. Few studies have focused on efficient methods of musical practice, although it is an essential element of all musical performance learning.
CHAPTER III
METHODOLOGY AND PROCEDURES

Methodology

Based on the background presented in Chapter I of this paper, a study was designed and tested to implement the motor schema concepts into a system of practice behavior. This study followed the design and limits described in Chapter I, and was conducted by this writer. As detailed earlier in this paper, the purpose of the study was to ascertain the effects of instruction in practice behavior on the performance abilities of selected instrumental music students. This instruction was based on the motor schema theory of musical learning as described by David LaBerge (1981).

Design of the Study

The design of the study was pretest/posttest, with an additional posttest. The pretest consisted of a selected etude (Etude A), as described later in this paper. Two interim tests were administered during the instructional period of the study in order to compile intermediate statistics, and to determine the results of the instruction at interim points of the study. These two tests, in addition to a final performance test, also made use of the Etude A. The additional posttest utilized a second etude (Etude B), intended to be of a greater degree of difficulty than Etude A. Etudes A and B are included in Appendix A.
The written etudes were prepared using the "Deluxe Music Construction Set" by Geoff Brown (1985) on the Apple Macintosh Plus computer, and printed on the Apple Laserwriter Plus printer.

Etude A was adapted by the researcher from Twenty Etudes by P. Clodomir (19- ). Etude B was adapted by the researcher from an etude by Tomaz Stanko (1970).

Once the original etude had been entered into the software program, octave adjustments were made for the various instruments in order to keep them within their normal playing ranges. These normal ranges were determined by using The Art of Conducting by Hunsberger and Ernst (1983). The etudes were validated by a panel of four college professors currently engaged in applied music teaching. The professors were selected from the following areas of applied undergraduate teaching: high brass (trumpet and horn), low brass (trombone, euphonium, tuba), high woodwinds (flute, oboe), single reeds (clarinet, saxophone) and strings. Validators were asked to evaluate the etudes presented by answering the following question: "As an applied instructor of undergraduate instrumental musicians, do you find this etude to be appropriate for, and generally representative of, material studied by those students?" The selected etudes were required to receive a positive response from all validators. The etudes were validated as being appropriate for undergraduate musicians.

The subjects in the study (N = 24) were all students at Heidelberg College in Tiffin, Ohio. The subjects were recruited by the researcher from the overall population of student musicians at that institution. The original group of participants numbered 32; due to disqualifications for various reasons, the final number of subjects was 24. The musicians were all undergraduate students, from a variety
of backgrounds, and with a variety of professional major study areas, including areas other than music. There was a mixed instrumentation, including woodwinds, brasses, and strings. The instrumentation included 4 flutes, 3 clarinets, 3 alto saxophones, 6 trumpets/cornets, 2 horns, 3 violins, and 3 cellos. Similar mixed groupings were used by Wagner (1975) and Madsen and Geringer (1981).

Administration and Evaluation of the Pretest

All participants were given a pretest, using Etude A. For this test, the musicians were allowed thirty minutes to examine the etude, and prepare it in any way they believed to be appropriate. It was requested, however, that the written etude not be marked in any way during this preparation period. Participants were required to sign the etude out when receiving it, and to sign in when returning to the test site. A copy of the full instructions given prior to the pretest is included in Appendix A.

At the end of the thirty-minute period, participants returned to the test site, where they were tape-recorded after having been given time to establish the marked tempo through listening to a metronome. At the time of the tape recording, each participant was assigned an identification number, which was read verbally by the test administrator onto the tape.

During the actual testing, the subjects were tape-recorded using a Technics stereo cassette tape deck, with Nakamichi microphones. As a backup unit, a Mitsubishi portable stereo cassette tape-recorder was used.

Upon completion of the pretest, copies of the tapes were submitted, along with printed copies of Etude A, to the adjudicators. The two outside adjudicators were both professors of applied music at the college level. One was
a specialist in brass performance and conductor of a college orchestra; the other was a specialist in string performance. Both had extensive experience in performance, applied teaching of college students, and evaluation of instrumental performances.

The adjudicators were given instruction in scoring the tests; a copy of the instructions given to the adjudicators is shown in Appendix B. The adjudicators were instructed to listen to the tapes while reading the printed etudes provided. The performance variables evaluated were:

(a) rhythmic accuracy, (b) dynamic accuracy, (c) accuracy of articulation, and (d) pitch accuracy. The category of pitch accuracy was interpreted to mean performing the pitches as notated, with an acceptable degree of accuracy of intonation in keeping with normal performance standards. Thus, no mechanical means of checking exact pitch was used, and minor variances from standard pitch were considered acceptable. When an error was heard in any of the four performance variables being evaluated, the measure in which the error took place was to be marked as incorrect.

Each measure of the etude was numbered. Each measure was considered to count as one point; an error in any of the four variables caused the measure to be scored as incorrect. The number of incorrect measures was then subtracted from 95 (the total number of measures being evaluated), and the difference represented the score. For example, a performer making errors in 27 measures would receive a score of 68. This manner of scoring of the test was similar to that employed in the Watkins-Farnum Performance Scale (1954). The Watkins-Farnum Scale was designed as a measure of performance ability; the method of scoring has been validated through use of this test.
After administration and scoring of the pretest, reliability of the test was determined. Reliability was computed by means of the KR-21 formula, and determined to be .92, which was well within acceptable ranges.

Control and Experimental Groups

After scoring of the pretest, participants were assigned to one of three groups using a matching procedure. Group assignment was determined through a random process, but with scores matched between groups. The scores were listed from highest to lowest, with the assigned identification number used rather than names of participants. Assignment to groups was accomplished as colored tokens representing the three groups were drawn from a container; the drawing was done by a neutral party. The first color drawn as a token was assigned to the highest score, the second color to the next highest score, and the third to the third highest score. Three tokens were used; thus, the three highest scores were divided between the three groups. This process was continued until the bottom of the list was reached.

For purposes of reporting, the three groups were designated as the Motor Schema Theory Group (MST), the Traditional Group (TG), and the Control Group (CG). After group assignment was complete, mean scores of the groups were computed in order to ascertain the beginning levels of the groups. Composition of the groups is shown in Table 1.
TABLE 1
Composition of the Experimental and Control Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>MUSIC MAJORS</th>
<th>NON-MUSIC MAJORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (CG)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional (TG)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Schema Theory (MST)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>(N = 24)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Of the 18 music majors, 13 were performing on their major instrument. The remaining 5 were performing on a secondary instrument on which they had acquired sufficient proficiency for this study.
After formation of the experimental groups and the control group, the groups were monitored for a period of eight weeks. The study group (MST) was given instruction in practice methodology based on the motor schema theory, as well as basic instruction in practice technique. The purpose of the basic instruction was to assure a common level of background within the group. This instruction utilized the techniques discussed in Chapter I, pages 7-14 of this study. This minimized basic differences in prior instruction in practice techniques between those with extensive applied training, moderate applied training, or no applied training at all. The group was tested, along with the other groups, at the conclusion of this basic instruction to determine the effect of this instruction on their performance of the selected etude. The content of the weekly treatment list is shown in Table 21 and outlines of the instruction given in each week are shown in Table 22. Each of these tables is included in Appendix C. A brief overview of the instruction given to each of the three groups is shown in Table 2. In addition, the MST group was assigned reading which consisted of the first five pages of Chapter I of this study.
TABLE 2
Treatment of the Motor Schema Theory (MST) and Traditional (TG) Groups

<table>
<thead>
<tr>
<th>WEEK</th>
<th>MST</th>
<th>TG</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Isolating problems; methods of problem solving.</td>
<td>No contact.</td>
</tr>
<tr>
<td></td>
<td>Interim Test 1</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Introduction: motor schema theory.</td>
<td>No contact.</td>
</tr>
<tr>
<td></td>
<td>Interim Test 2</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Larger scale schema; using different schema.</td>
<td>Setting goals; forming long and short term goals.</td>
</tr>
<tr>
<td>8.</td>
<td>Using larger schema; review and summary.</td>
<td>No contact.</td>
</tr>
</tbody>
</table>
The second group (TG) was also given instruction, and encouraged to practice as well. However, this group did not receive instruction in formation of schema; rather, their instruction was identical to that given to the MST Group during the first three weeks of instruction. Again, this instruction was based on the techniques discussed in Chapter I, pages 7-14. Content of the weekly sessions with the Traditional Group is shown in Table 23 (found in Appendix C); it can be seen that they received initial instruction in practice, but did not utilize the specific materials which were given to the MST Group.

All instruction to the MST and TG groups was given as group instruction. Instruction sessions were one hour in length. Thus, the MST group received a total of 8 hours of instruction over the 8 weeks of the study; the TG group received a total of 4 hours of instruction over the 8 weeks of the study.

The Control Group (CG) was designated as a no-contact group. The members of this group received initial orientation, were encouraged to practice, and utilized the practice logs, but otherwise received no instruction in practice.

Throughout the duration of the experiment, all participants were required to keep a log of practice time spent, procedures utilized, and materials studied. The log also had weekly evaluations by participants of what was achieved during that week, and their thoughts about the week's practice. All practice logs were collected on a weekly basis in order to insure that the records were being kept current, rather than compiled at the end of the study period. Materials used in the log are shown in Forms III-D
and III-E. Copies of these forms are included in Appendix C. Studies involving similar use of practice records were done by Madsen and Geringer (1981) and Wagner (1975).

Administration and Evaluation of Interim Tests

During the course of the experimental period, the participants were administered two additional performance tests. The materials (Etude A) and procedures used were identical to those of the pretest. These tests were designated as interim test 1 and interim test 2. The purpose of these tests was to establish interim records for possible improvement within and between the groups. Interim test 1 was administered at the end of Week 3 in the study, following the MST Group's completion of instruction in basic practice techniques. Interim test 2 was administered at the end of the sixth week of the study, after the MST Group had received initial instruction in motor schema theory. Each of these tests used Etude A, and each allowed a 30-minute practice period prior to testing.

The interim tests were evaluated in identical fashion to the pretest. The adjudicators received copies of the etude and tape-recordings of the performance tests. They were instructed to evaluate the interim tests exactly as they had the pretest.

Administration and Evaluation of the Posttests

At the conclusion of the experimental period, all groups were administered a posttest (posttest 1), which was again identical to the pretest in materials and procedures. Participants were allowed thirty-minutes practice time in which to prepare the etude. Participants were again tape-recorded in the same manner as was used for the pretest, and the recordings were submitted for evaluation
by the adjudicators.

Also at the conclusion of the experimental period, a second posttest measure was utilized. This test used both a different etude (Etude B) and different procedures. The purpose of this test was to determine differences between the groups when given a more substantial amount of time to practice and prepare the material. This second posttest was designated as posttest 2.

Participants were allowed four days in which to prepare Etude B for posttest 2. All participants received the etude on a Friday afternoon; the recording of the test took place on the following Tuesday. Participants were once again given time to establish the marked tempo of the etude through listening to a metronome, and the test was tape-recorded.

For posttest 2, the selected etude was intended to be more difficult rhythmically and technically. Due to the technical difficulty of the etude, the scoring procedure was varied slightly. The etude was written with four beats per measure; however, for scoring purposes, each measure was divided in half, resulting in two-beat segments.

This was done for two reasons: (a) to simplify scoring, and (b) to allow for the difficulty of the material. This division also allowed posttest 2 to be adjudicated more similarly to the pretest, which also contained two beats per each measure evaluated. For the posttest 2, only the first 25 measures of the selected etude were evaluated; after the division of the measures, therefore, the total possible score was 50.

Thus, in the first part of the testing, involving Etude A, the amount of practice preceding test tape-recording was strictly controlled, and all participants were restricted to the same amount of practice. This was intended to
measure the efficiency of the time spent in practicing, and to allow comparisons between the groups in a controlled situation. For the second portion of the testing, involving Etude B, the participants were allowed to practice as much as they saw fit. This expanded time was designed to allow for greater formation of mental schema in preparation of the etude, and allow contrasts between those with the varying degrees of instruction in practice technique and schema formation. Etudes A and B are included in Appendix A.

After compilation of the data from the tests, a Multivariate Analysis of Variance (MANOVA) was run between the groups, and trends noted. These analyses sought to establish whether or not the evidence gathered from the tests supported the original hypothesis. Conclusions were drawn based on the data gathered, and recommendations for further study made, and for implementation of these concepts in the teaching of performance skills to instrumental music students.

Additional Procedures

Additional data for this study were collected in a variety of manners. In terms of written materials, participants in the study were required to maintain two types of weekly reports. The first of these was the Practice Log (Form III-D, shown in Appendix C). Participants were required to record the amount and type of practice performed during each of the eight weeks of the experimental period, and those in the two contact groups (MST and TG) were required also to specify when they were using the various practice techniques described to them during the group meetings. These reports were collected weekly in order to be certain that practice records were
being kept current, rather than compiled at the end of the experiment. Summaries of the practice logs are given in Chapter Four, and the reports are analyzed.

The second type of written material required of participants was the Weekly Practice Evaluation (Form III-E, also included in Appendix C). On this form, participants were asked to respond to a number of statements by choosing the most appropriate number from a scale of 1-5. These questions concerned the feelings of the musicians in regard to the type of practice situations, adequacy of practice time, clarity of procedures used, and other matters. In addition, comments concerning the week's practice were solicited. The purpose of this form was to encourage thought and expression about the issues discussed in group meetings, or which came up during the week's practice. It also allowed participants to have a degree of input concerning the practice procedures. This form was also collected weekly. Responses to this form are summarized and analyzed in Chapter Four.
CHAPTER IV
RESULTS

Introduction
This chapter is divided into three sections: (a) presentation and evaluation of results of the analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA), based on the group test scores from the pretest, interim tests 1 and 2, and posttests 1 and 2; (b) presentation and discussion of practice records of the three groups, based on data from Form III-D, the Practice Log; and (c) presentation and discussion of data from Form III-E, the Weekly Practice Evaluation.

Test Scores of Groups
Each participant in the three groups was evaluated on a series of tests of musical performance, designated as the pretest, interim test 1, interim test 2, and posttest 1. All were also evaluated on an additional test of musical performance, called posttest 2. As has been noted, all tests except posttest 2 used a single etude, Etude A. Posttest 2 used a second etude, designated Etude B.

The tests were administered at designated points of the experimental period in order to ascertain changes in group scores from those established with the pretest. These points were: (a) after the third week of the experimental period, (b) after the sixth week of the experimental period, and (c) at the conclusion of the experimental period. These scores are presented in Table 3, and analyzed following the table.
TABLE 3
Test Scores of Experimental and Control Groups

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>CG</td>
<td>56.18</td>
<td>14.83</td>
</tr>
<tr>
<td></td>
<td>TG</td>
<td>55.63</td>
<td>15.97</td>
</tr>
<tr>
<td></td>
<td>MST</td>
<td>57.11</td>
<td>18.78</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>56.92</td>
<td>16.42</td>
</tr>
<tr>
<td></td>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interim Test 1</td>
<td>CG</td>
<td>68.69</td>
<td>12.58</td>
</tr>
<tr>
<td></td>
<td>TG</td>
<td>65.57</td>
<td>17.51</td>
</tr>
<tr>
<td></td>
<td>MST</td>
<td>74.29</td>
<td>13.85</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69.48</td>
<td>14.43</td>
</tr>
<tr>
<td></td>
<td>(N = 24)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 3 continued
Test Scores of Experimental and Control Groups

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interim Test 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>68.88</td>
<td>14.61</td>
</tr>
<tr>
<td></td>
<td>TG</td>
<td>68.29</td>
<td>20.24</td>
</tr>
<tr>
<td></td>
<td>MST</td>
<td>71.56</td>
<td>15.46</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69.63</td>
<td>16.06</td>
</tr>
<tr>
<td>Posttest 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>69.19</td>
<td>12.34</td>
</tr>
<tr>
<td></td>
<td>TG</td>
<td>70.50</td>
<td>15.20</td>
</tr>
<tr>
<td></td>
<td>MST</td>
<td>79.93</td>
<td>13.15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>73.30</td>
<td>13.54</td>
</tr>
</tbody>
</table>
TABLE 3 continued
Test Scores of Experimental and Control Groups

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest 2</td>
<td>CG</td>
<td>23.69</td>
<td>10.28</td>
</tr>
<tr>
<td></td>
<td>TG</td>
<td>26.85</td>
<td>13.46</td>
</tr>
<tr>
<td></td>
<td>MST</td>
<td>31.25</td>
<td>12.58</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>26.88</td>
<td>11.90</td>
</tr>
</tbody>
</table>

**Treatment of Test Data**

The data were treated by using both an analysis of variance (ANOVA) and a multivariate analysis of variance (MANOVA). The ANOVA and MANOVA were conducted by means of the SPSS-X Statistical Program on a Prime 9955 mainframe computer.

The ANOVA was conducted in order to determine if significant statistical difference between the groups was shown during the following portions of the experimental period: (a) from the pretest to interim test 1; (b) from interim test 1 to interim test 2; and (c) from interim test 2 to posttest 1. It was recognized that this type of repeated analysis can lead to a Type I statistical error. However, an a priori decision was made to conduct the tests in order to examine the significance, if any, of the instruction given during these portions of the experimental period. The standard for statistical significance was set at the .05 level.
All test data were also entered into the SPSS-X statistical program, and a MANOVA conducted for scores between groups for the four tests utilizing Etude A. The purpose of this analysis was to determine whether statistically significant change had taken place during the entire eight-week testing period. The standard for statistical significance was set at the .05 level.

For posttest 2, the scores were likewise entered into the SPSS-X program, and an analysis of variance (ANOVA) was run on a comparative basis, comparing the scores between the groups. This was necessary, since there was no other repetition of this Final Test from which to draw comparisons.

The results of the MANOVA and ANOVA tests are shown in the tables on the following pages. After presentation of the tables, the results are analyzed for significance.

**Analysis of Test Scores**

From the scores presented in Table 3 it can be seen that each of the three groups showed improvement in the mean scores of the tests on Etude A during the term of the study. It also can be seen that the Motor Schema Theory Group improved more than did the other two groups. Improvement in the scores seemed to follow a clear pattern; each of the groups made a large jump in mean score from the pretest to interim test 1. Of the three, the Motor Schema Theory Group showed the largest gain in score, with an increase of more than seventeen points. A second jump in scores was made by the three groups between interim test 2 and posttest 1.
Results of Analysis of Variance

The results of the ANOVA for group test scores on the pretest are shown in Table 4.

TABLE 4
Test of Significance for Pretest
Analysis of Variance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Cells</td>
<td>21</td>
<td>880.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1</td>
<td>424669.01</td>
<td>482.38</td>
<td>.000</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>395.57</td>
<td>.45</td>
<td>.644</td>
</tr>
</tbody>
</table>

Table 4 shows that there were no significant differences between the groups on the pretest scores. Thus, the matching procedure was shown to have been effective in the assignment of participants to the three groups.

Table 5 shows the results of the ANOVA for the period between the pretest and interim test 1. During this time, instruction was given to the MST in traditional procedures for practicing, while the TG received introductory instruction in practice techniques. The CG, of course, received no instruction.
<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>3</td>
<td>654.95</td>
<td>2.72</td>
<td>.05</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>106.75</td>
<td>0.44</td>
<td>.65</td>
</tr>
<tr>
<td>Test</td>
<td>1</td>
<td>1750.65</td>
<td>7.28</td>
<td>.01</td>
</tr>
</tbody>
</table>

The heading of "main effects" is a combination of the effects of group assignment and the difference in scores between the two tests. It can be seen as representing the effect of the treatment given to the groups. This combined measure shows a significant change at the .05 level from the pretest to interim test 1. It can be concluded that there was a significant difference between the groups based on these two factors.

Table 5 shows that there was a significant difference between the scores of the groups from the pretest to interim test 1. The significance of the scores is shown at .01, which is well within the acceptable range.
While the main effects showed significant difference during this period of instruction, the difference appears to be primarily due to the significant change in test scores in each of the three groups, and due less to the assignment to group. Group assignment was not shown to be statistically significant at this point.

Table 6 shows the result of the ANOVA for the period between interim test 1 and interim test 2.

TABLE 6
Test of Significance for Interim Test 1 to Interim Test 2
Analysis of Variance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>3</td>
<td>89.12</td>
<td>0.36</td>
<td>.78</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>133.55</td>
<td>0.54</td>
<td>.59</td>
</tr>
<tr>
<td>Test</td>
<td>1</td>
<td>.00</td>
<td>.00</td>
<td>.99</td>
</tr>
</tbody>
</table>

Table 6 shows that there was no significant difference between the scores of the groups for the period between interim test 1 and interim test 2. At this point in the instruction, no significant difference can be shown due to the treatment. As demonstrated by the "test" caption in Table 6, there was very little change in the scores of the groups between interim test 1 and interim test 2.
Table 7 shows the result of the ANOVA for the period between interim test 2 and posttest 1. This period coincided with further instruction in motor schema theory for the MST group, and instruction in practice planning and goal setting for the TG group.

**Table 7**

Test of Significance for Interim Test 2 to Posttest 1.

Analysis of Variance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>3</td>
<td>199.87</td>
<td>0.88</td>
<td>.46</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>222.20</td>
<td>0.97</td>
<td>.39</td>
</tr>
<tr>
<td>Test</td>
<td>1</td>
<td>155.22</td>
<td>0.68</td>
<td>.41</td>
</tr>
</tbody>
</table>

Table 7 shows that the instruction or lack of instruction received by the three groups during the period between interim test 2 and posttest 1 cannot be shown to have produced significant differences in the scores. The instruction received during this period cannot be shown to have produced significant differences in the scores of the groups.
Results of Multivariate Analysis of Variance

The MANOVA was used to determine whether there were significant differences between the groups throughout the entire eight-week instructional period. Although the ANOVA tests presented previously can be used to show possible effects of the instruction at designated times during the eight weeks, the MANOVA was necessary in order to assess the effects of the instruction during the complete experimental period. Results of the MANOVA are shown in Table 8.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Cells</td>
<td>21</td>
<td>20.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>1</td>
<td>2783.13</td>
<td>133.29</td>
<td>.000</td>
</tr>
<tr>
<td>Group by Test</td>
<td>2</td>
<td>133.38</td>
<td>6.39</td>
<td>.007</td>
</tr>
</tbody>
</table>

Table 8 shows the results of the MANOVA analysis for the entire test period in relation to the significance of the different groups, and hence to the treatment given to the groups. It can be seen that the significance of the
category "Group by Test" is very high, at .007. This indicates that there was a significant difference between the groups during the test period encompassing the pretest to posttest 1, or on all the performance tests utilizing Etude A. Thus, it can be concluded that the treatment given to the groups resulted in differences in their scores which were significant beyond the .05 level. The null hypothesis was rejected; the treatment was shown to have produced significant difference between the groups, in favor of the Motor Schema Theory (MST) Group. However, no significant difference was shown between the Control Group (CG) and the Traditional Group (TG).

Results of Analysis of Variance for Posttest 2

Participants were allowed four days in which to prepare Etude B prior to testing. Results were then evaluated for significance using an analysis of variance. The result of the ANOVA is shown in Table 9.

TABLE 9
Test of Significance for Posttest 2
Analysis of Variance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>2</td>
<td>99.67</td>
<td>.68</td>
<td>.52</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>99.67</td>
<td>.68</td>
<td>.52</td>
</tr>
</tbody>
</table>
For posttest 2 a second, more difficult etude was selected (Etude B). Raw scores seen in Table 3 (page 48) from the three groups show that the Control Group scored the lowest of the three, utilizing only practice procedures known to them prior to the experimental period. The Traditional Group scored higher than the Control Group. The highest scores were demonstrated by the Motor Schema Theory Group, with a group mean score of 31.25.

As previously discussed, this data was analyzed by comparing the mean group scores with the SPSS-X statistical software on the Prime 9955 computer. While the Motor Schema Theory Group showed the highest raw score, the ANOVA did not show this score to be statistically significant at the .05 level in comparison with the remaining two groups.

**Comparison of Weekly Practice Logs**

The results of Form III-D (weekly practice log) are shown in Table 10. Table 10 first presents the mean weekly practice totals per group for those in the Traditional Group (TG). The table also shows mean practice amounts for the Motor Schema Theory and Control Group, respectively. The group mean for each of the three groups for the entire eight-week experimental period is also shown.

**Analysis of Practice Logs**

A single individual from the Motor Schema Theory reported unusually large amounts of practice for each of the eight weeks of the study. In fact, this participant reported greater amounts of practice than the combined totals of any of the other groups, including the total remaining practice times from the Motor Schema Theory Group. The weekly mean for this individual was 2325 minutes (38.75 hours); as can be seen from Table 10, this
influenced the mean practice amounts of this group to a considerable degree. There is every reason to believe that these reports are accurate; the procedures are well documented on Form III-D, and professors (including the applied professor) report that the amount of practice reported by this individual was in keeping with the individual's normal practice routine.

TABLE 10
Practice Records of MST, TG, and CG Groups

<table>
<thead>
<tr>
<th>WEEK</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>262.50</td>
<td>167.50</td>
<td>444.67</td>
<td>339.17</td>
<td>296.67</td>
<td>369.17</td>
<td>410.75</td>
<td>499.25</td>
<td>348.71</td>
</tr>
<tr>
<td>CG</td>
<td>200.63</td>
<td>221.88</td>
<td>301.88</td>
<td>193.38</td>
<td>206.25</td>
<td>167.50</td>
<td>205.00</td>
<td>282.50</td>
<td>222.38</td>
</tr>
<tr>
<td>MST</td>
<td>551.88</td>
<td>410.63</td>
<td>550.63</td>
<td>631.25</td>
<td>686.43</td>
<td>624.29</td>
<td>659.29</td>
<td>606.43</td>
<td>549.48</td>
</tr>
<tr>
<td>*</td>
<td>356.43</td>
<td>285.00</td>
<td>256.43</td>
<td>292.86</td>
<td>340.83</td>
<td>388.33</td>
<td>369.17</td>
<td>277.50</td>
<td>320.82</td>
</tr>
</tbody>
</table>

* Note: One participant in the MST group reported an unusually high practice total for each week of the study, with a weekly mean of 2325 minutes. Since this total greatly influenced the weekly means for the MST group, the second set of figures denoted with the asterisk (*) represent the means for the remainder of the participants.
in the MST Group. This allows for a secondary set of comparisons between the three groups.

It can be seen, then, that the Motor Schema Theory Group reported the highest totals for practice in each of the eight weeks. In presenting the data for this group (p. 57), a second set of numbers is also reported, representing the mean practice time of the students in the group without the highest individual. While it is not entirely accurate to remove the scores of any member of a group, for the purposes of comparison these secondary scores will be included in the analysis which follows.

The MST Group (sans extreme score) reported the highest practice amounts in weeks one, two, five and six. The Traditional Group reported the highest practice amounts in weeks three, four, seven and eight. While the Control Group did not report the highest practice amounts in any of the eight weeks, their totals surpassed those of the MST in weeks three and eight.

The practice totals for all subjects indicate that the mean daily practice for individuals was 56.26 minutes, approximately 6.50 hours per week. If the totals are adjusted to remove the total of the single individual mentioned previously, the mean is 39.40 minutes per day per individual, and a weekly mean of 4.59 hours. It can be readily seen that this individual had a profound influence on the practice totals of the MST, and on the three groups combined.

**Analysis: Weekly Practice Evaluation**

As has been previously stated, the purposes of Form III-E were to encourage the participants to think in an organized manner about their practice time and the
organization and efficiency of the practice. Also, the forms allowed the subjects a degree of input concerning their feelings about the weekly practice and weekly group meetings, when appropriate.

The intent of the statements appeared to be clear, even though the statements were not defined in greater detail than they appear on the form. Not every participant supplied an answer for each statement in every week. Some statements were more applicable to the Motor Schema Theory Group or Traditional Group at times, and perhaps more applicable to the Motor Schema Theory Group in some cases than either of the remaining two groups. Thus, some of the mean numbers supplied on the following pages for weekly responses will not appear as multiples of eight (i.e., n per group). Participants seemed to believe that the statements applied more to their work in some weeks than in others, depending on the amount of practice time, the procedures used for that week, and perhaps other factors.

Also included with Form III-E was a sheet for supplying written comments. Again, not all participants chose to do so, and some comments proved to be more anecdotal information than statements having to do with the study. However, selected comments which dealt with items of the study are included in Appendix D of this study.

The participants were asked to respond to all statements by indicating a number from the following scale: 1-excellent/strongly agree; 2-good/agree; 3-average; 4-below average/disagree; 5-poor/strongly disagree. Thus, stronger agreement with a statement is indicated by lower numbers. For example, a mean of 2.25 indicates stronger agreement than does a mean of 2.80.

Mean responses for each of the eight weeks are shown in Table 11.
### TABLE 11
Responses to Statement 1
This was an effective week of practice for me.

<table>
<thead>
<tr>
<th>WEEK</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>2.33</td>
<td>3.50</td>
<td>2.67</td>
<td>2.00</td>
<td>2.60</td>
<td>3.00</td>
<td>2.20</td>
<td>2.83</td>
<td>2.64</td>
</tr>
<tr>
<td>(n = 8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG</td>
<td>3.50</td>
<td>3.38</td>
<td>3.13</td>
<td>3.43</td>
<td>2.29</td>
<td>3.14</td>
<td>2.43</td>
<td>1.86</td>
<td>2.89</td>
</tr>
<tr>
<td>(n = 8)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MST</td>
<td>2.75</td>
<td>3.00</td>
<td>2.25</td>
<td>2.75</td>
<td>2.38</td>
<td>2.25</td>
<td>2.86</td>
<td>2.00</td>
<td>2.28</td>
</tr>
<tr>
<td>(n = 8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/ Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree

In Statement 1, which dealt with the effectiveness of the week's practice, there appears to be no clear trend in the responses. While the responses of those in the Control Group appear to be less favorable early in the eight weeks, they show improvement later in the period, and actually surpass those of the other groups by the end. The combined mean score for the Control Group is 2.89; for the Traditional Group the combined mean score is 2.64; for the
Motor Schema Theory Group the combined mean score is 2.28. These scores show no large variance from group to group. While the mean practice amounts vary considerably, the feelings of the participants regarding the effectiveness of the practice do not, as shown in Table 11.

**TABLE 12**

Responses to Statement 2
I understood the goals of this week's practice.

<table>
<thead>
<tr>
<th>WEEK</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>3.00</td>
<td>3.00</td>
<td>2.50</td>
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<td>2.20</td>
<td>2.33</td>
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</tr>
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<td>CG</td>
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<td>2.50</td>
<td>2.83</td>
<td>2.60</td>
<td>3.00</td>
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<td>2.17</td>
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<td></td>
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<tr>
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<td>2.25</td>
<td>2.00</td>
<td>2.57</td>
<td>2.40</td>
<td>2.25</td>
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<tr>
<td>(n = 8)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/ Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
In Statement 2 (Table 12), the trend appears to be similar to Statement 1. Participants were asked to evaluate their understanding of the week's practice goals. The lowest scores, which indicate stronger agreement with the statement, are reported by the Motor Schema Theory Group. The group mean for the eight weeks for this group is 2.25. This should not be surprising, since participants in this group were meeting weekly, and had more frequent opportunities to discuss their goals than did the other two groups. Members of the Control Group again reported less agreement during the opening weeks of the study, with a noted improvement in the final two weeks, even surpassing the Motor Schema Theory Group during these weeks. It might be surmised that their goals became more apparent as the end of the study neared; indeed, perhaps completing the study was a goal for some group members. The group mean for the eight-week period was 2.69. The Traditional Group began with the least agreement of the three groups, with their responses indicating only "average" agreement with the statement. Interestingly, their responses reached a low point (strongest agreement with the statement) in week 4, from which point they rose gradually back toward their original rankings. Weeks 3 and 4 of the study were those in which this group was discussing methods of problem solving in practice. It may be assumed that this discussion led group members to think that they were working more efficiently toward their practice goals. The mean group response for the eight weeks for this group was 2.52.

Statement 3 was related to Statement 2. Participants were asked to evaluate whether goals were "reasonable and achievable". Group scores were similar to those for Statement 2 as well.
Table 13
Responses to Statement 3
My goals for this week were reasonable and achievable.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>2.33</td>
<td>2.50</td>
<td>2.17</td>
<td>2.50</td>
<td>2.20</td>
<td>3.17</td>
<td>2.50</td>
<td>3.00</td>
<td>2.52</td>
</tr>
</tbody>
</table>

\( n = 8 \)

| CG   | 2.75 | 3.00 | 2.83 | 3.20 | 2.50 | 3.40 | 2.40 | 2.80 | 2.86 |

\( n = 8 \)

| MST  | 2.00 | 2.25 | 2.25 | 2.50 | 2.57 | 2.14 | 2.43 | 2.40 | 2.32 |

\( n = 8 \)

Scale:
1-Excellent/ Strongly Agree
2-Good/Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
For Statement 3 (Table 13), the group mean for the Traditional Group was 2.52; for the Control Group it was 2.86; for the Motor Schema Theory Group it was 2.32. Each of these indicated slightly less agreement with the statement in comparison to Statement 2, with the greatest increase being seen in the Control Group. Still, all group responses were slightly more favorable than the 3.00 level, which would indicate "average" agreement with the statement. Thus, all groups reported greater than average agreement that their goals were "reasonable and achievable."

In Statement 4 (Table 14), participants were asked to indicate whether or not they understood the procedures for the week's practice. Since the Control Group did not actually have procedures designated by the study, presumably their procedures were of their own choosing. In spite of this, the responses from this group indicated less agreement with the statement than those of either of the other two groups. This statement, however, drew the strongest agreement of any for the three groups together; only the Control Group responded more positively to any other statement (Statement 7). Both the Motor Schema Theory Group and Traditional Group gave this statement their strongest agreement. Not surprisingly, since the group received more instruction, the Motor Schema Theory Group responded very strongly to this statement. Group mean scores for Statement 4 were as follows: Traditional Group 2.37; Control Group 2.64; Motor Schema Theory Group 2.07.
Table 14
Responses to Statement 4
I understood the procedures utilized for this week's practice.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
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<td>3.00</td>
<td>1.67</td>
<td>1.75</td>
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<td></td>
</tr>
<tr>
<td>CG</td>
<td>2.00</td>
<td>2.67</td>
<td>2.67</td>
<td>3.00</td>
<td>2.75</td>
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<td>MST</td>
<td>1.60</td>
<td>2.00</td>
<td>2.00</td>
<td>1.71</td>
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<td>2.38</td>
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<td>2.20</td>
<td>2.07</td>
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</tr>
</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/ Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
Table 15
Responses to Statement 5
My overall practice time for this week was adequate.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
<th>8</th>
<th>Avg.</th>
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</thead>
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<tr>
<td>TG</td>
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<td>3.67</td>
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<td>2.50</td>
<td>2.43</td>
<td>3.25</td>
<td>2.71</td>
<td>2.20</td>
<td>2.85</td>
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<td>(n = 8)</td>
</tr>
</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
Statement 5 (Table 15) received the least agreement of any of the ten statements. This statement dealt with the adequacy of overall practice time for the week. The clear implication was that participants were less satisfied with the amount of practice time they had spent than with the procedures or the organization of that time. In fact, the Control Group indicated a response midway between the classifications of "average" and "disagree" for this statement. This was the only time that any group mean score rose above the 3.00 level. It is interesting to note, however, that members of this group reported much greater satisfaction during the final two weeks of the study, similar to the trend of their report for Statement 2. Mean scores for each group on this statement were: Control Group 3.45; Traditional Group 2.98; Motor Schema Theory Group 2.85.

Statement 6 (Table 16) asked participants to reflect on the balance of mental and physical practice. All group mean scores indicated mild agreement with this statement, with the strongest agreement coming from the Traditional Group. Only for Statement 6 did the Traditional Group indicate the strongest agreement of the three groups. The group mean score for this group was 2.53, slightly stronger than the Motor Schema Theory Group score of 2.62. Again, the Control Group indicated the weakest degree of agreement, with a mean score of 2.94, again in the "average" range.
Table 16
Responses to Statement 6
My practice time displayed a balance between mental and physical practice.

<table>
<thead>
<tr>
<th>Week</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
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<td>1.83</td>
<td>2.75</td>
<td>2.80</td>
<td>2.53</td>
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<td></td>
</tr>
<tr>
<td>MST</td>
<td>3.20</td>
<td>3.14</td>
<td>2.29</td>
<td>2.43</td>
<td>1.83</td>
<td>2.86</td>
<td>3.00</td>
<td>2.20</td>
<td>2.62</td>
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</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
Table 17
Responses to Statement 7
My goals for this week built logically on past work, and lead logically toward future work.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
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<tr>
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<td>2.17</td>
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<td>3.00</td>
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<td>2.75</td>
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</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
Statement 7 (Table 17) was another statement dealing with goals, similar in some ways to Statements 2 and 3. This statement certainly was more reflective of the materials being presented to the Motor Schema Theory Group, with the implication of continued planning, connection of goals and ideas, and continuing development of themes. The degree of agreement reflected this trend, with the Motor Schema Theory group reporting a mean score of 2.38. The next strongest degree of agreement, however, came not from the Traditional Group, where it might have been expected, but from the Control Group, with a mean score of 2.44. The Traditional Group reported a mean score of 2.57.

Statement 8 (Table 18) regarded the amount of progress observed during practice periods. The three groups were relatively close in the responses, with the MST and TG Groups reporting scores of 2.50 and 2.55 respectively. The Control Group was considerably higher at 2.84, indicating that these group members did not feel as strongly that they were making steady progress. This lack of progress could have been due to lack of motivation, since the group was not meeting; from lack of adequate practice time; or from lack of perceived direction in the practice efforts.

Statement 9 (Table 19) concerned the efficiency of the practice procedures. It would seem logical that the groups spending the most time in meetings and receiving the greater amounts of instruction in practice methodology and procedures would respond most strongly in agreement with this statement. This assumption proved to be accurate; not only did the Motor Schema Theory Group agree most strongly, but there was considerable difference in the strength of the responses. The mean for the Motor Schema Theory Group was 2.40, indicating relatively strong agreement. For the Traditional Group, the mean was a somewhat weaker 2.65,
### Table 18

Responses to Statement 8

I think that I am making steady progress in my practice time.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>3.17</td>
<td>2.75</td>
<td>2.00</td>
<td>2.00</td>
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<td></td>
</tr>
<tr>
<td>CG</td>
<td>2.63</td>
<td>3.50</td>
<td>3.25</td>
<td>3.00</td>
<td>3.17</td>
<td>3.14</td>
<td>2.14</td>
<td>1.86</td>
<td>2.84</td>
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<tr>
<td>MST</td>
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<td>2.88</td>
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</tr>
</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/ Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
indicating a more moderate degree of agreement. The Control Group mean was 2.91, again near the "average" level.

The final responses were to Statement 10 (Table 20), in which participants were asked whether they saw clear and positive results from the week's practice. Once again, it would seem logical that the higher contact groups would agree more strongly. The Motor Schema Theory and Traditional Groups were relatively close in their responses, with mean scores of 2.48 and 2.57 respectively. The Control Group reported less agreement at 2.83. However, this group once again reported strong agreement during the last two weeks of the study, with the strongest weekly scores recorded for this statement.

As has been noted, virtually all mean scores were lower than the 3.00 level which would indicate "average" agreement with the statements. The Motor Schema Theory Group consistently agreed with the statements more strongly than the remaining two groups, with the Traditional Group generally second. The Control Group most frequently reported less agreement with the statements. This order, of course, is in keeping with the amount of contact the groups were allowed with the instructor, and possibly the amount of encouragement received through peer contact in the group as well. Based on the responses reported here, it is clear that members of the Motor Schema Theory Group thought that their goals, methods, and procedures were superior to those of the Traditional and Control Groups. The information reported thus far would seem to support the conclusion that Motor Schema Theory Group members both practiced more than their peers, and felt more positively about the procedures utilized in their practice.
Table 19

Responses to Statement 9
My practice time this week utilized efficient practice procedures.

<table>
<thead>
<tr>
<th>Week</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
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<td>3.67</td>
<td>2.00</td>
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<td></td>
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<tr>
<td>CG</td>
<td>2.63</td>
<td>3.38</td>
<td>3.13</td>
<td>3.83</td>
<td>3.00</td>
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</tr>
</tbody>
</table>

Scale:
1-Excellent/ Strongly Agree
2-Good/ Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
Table 20
Responses to Statement 10
I see clear, positive results from this week’s practice.

<table>
<thead>
<tr>
<th>Week</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
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<td>3.50</td>
<td>2.00</td>
<td>1.83</td>
<td>2.00</td>
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Scale:
1-Excellent/ Strongly Agree
2-Good/ Agree
3-Average
4-Below Average/ Disagree
5-Poor/ Strongly Disagree
Inter-Judge Reliability

As a measure of reliability between judges, interjudge reliability was computed for interim test 1 and posttest 2, by establishing a correlation of the adjudicators' scores. The correlation of scores indicated a reliability factor of .91 for interim test 1, and .92 for posttest 2. Both were well within the acceptable range.
CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter is divided into four sections: (a) a summary of the research project, (b) the results of the study, (c) conclusions reached on the basis of the findings, and (d) recommendations for further research interested in the efficiency and effectiveness of various practice techniques, and to those interested in the possible applications of the motor schema theory, as proposed by David LaBerge (1981), in the teaching of music.

Summary

The purpose of this study was to determine whether a motor schema approach to musical learning could be applied to increasing efficiency in musical practice. The need for the study was based on the relative lack of research in musical practice, and upon written recommendations by authorities in the field.

This study involved 24 undergraduate musicians, all students at Heidelberg College in Tiffin, Ohio. The musicians included performers on brass, woodwind, and string instruments. All had achieved a level of proficiency on their respective instruments which would classify them as being beyond the beginning level of performance. The study included both 18 music majors (those majoring on either a bachelor of music or a
bachelor of arts degree with a major area in music) and 6 non-music majors. Of the 18 music majors, 13 were performing on the instrument which was designated as their major instrument; the remaining 5 were performing on a secondary instrument with which they had acquired sufficient technique for the purposes of this study.

The participants were tested with a pretest etude. The etude was validated by a panel of applied college teachers, each of whom had as an area of expertise one or more of the instruments utilized in the study. For the pretest, the musicians were allowed thirty minutes to examine the etude, and prepare it in any way they believed to be appropriate. At the end of the thirty-minute period, the musicians returned to the testing site, where they were tape-recorded after having been given time to establish the marked tempo by listening to a metronome.

Copies of the recorded etudes were then submitted to a panel of two judges, each a teacher of applied instrumental music at the college level. These adjudicators did not know the identities of the performers; their only information was identification numbers on the tape recordings. Each adjudicator was instructed in methods of scoring for the tests. The variables evaluated were: rhythmic accuracy, dynamic accuracy, accuracy of articulation, and accuracy of pitch. When the adjudicator heard an error in any one of these variables, the measure in which it took place was to be marked as incorrect. The number of incorrect measures was then subtracted from 95, the number of measures being evaluated. A measure of reliability for the pretest was determined by using the KR-21 formula on the data. The reliability for this test was determined to be .92, which is well within the
acceptable range.

After determining scores on the pretest, participants were assigned to one of three groups through a matching procedure. The three highest scores on the pretest were divided between the groups, and similar matching of scores took place throughout the remainder of the scores. Other than this score matching, assignment to the groups was random. This random assignment was done in order to assure that the groups were as equal as possible at the beginning of the study. An evaluation of the mean scores of the three groups determined that there were no significant differences between the groups.

The three groups were assigned titles which were indicative of the treatment received. One group was designated as a no-contact group, a second group met on alternate weeks for a total of four meetings during the eight-week period, and the third group met for each of the eight weeks. All meetings were held in group, rather than individual, settings. These group meetings each were one hour in length.

The no-contact group was designated the Control Group. This group did not meet at all during the eight-week experimental period, except to complete the subsequent tests of the etude. No instruction in practice technique was given to members of this group. Group members were required, however, to keep records of the amount of practice time for each day of the study and practice procedures utilized, as were the members of the other two groups.

The Traditional Group was designated as a limited contact group. Members of this group received instruction which centered around problem-solving and recommended
procedures for practicing. These procedures were thought to be similar to those commonly used in studio teaching of applied music. The instruction was based on the procedures discussed in pages 7-14 of this paper. Traditional Group members met a total of four times with the investigator, with each meeting being one hour in length.

The Motor Schema Theory group was the high contact group. Members of this group met weekly with the instructor, and received instruction in problem-solving and practice procedures identical to that received by the Traditional Group. In addition, this group also received both introductory and extended instruction in the motor schema theory of musical learning, and instruction in application of it during practice times. Group members were also assigned reading concerning the motor schema theory, and required to analyze their own music for possible uses of schema.

All participants were tested a total of five times, including the pretest. Four of these tests used the original etude (Etude A), and the fifth, designed as an additional posttest, used a second etude (Etude B). For each test of Etude A, the participants were allowed a total of 30 minutes practice time. For Etude B, participants were allowed four days preparation time, with the amount and type of practice performed left to the discretion of the individual.

Each of the tests was evaluated by the adjudicators in a similar fashion. Interjudge reliability was determined by correlations of the scores of interim test 1 and posttest 2. These scores were .91 and .92, respectively. Reliability was judged to be acceptable.
Following completion of the study, an analysis of variance (ANOVA) and a Multivariate Analysis of Variance (MANOVA) were run, using the SPSS-X statistical software program on a Prime 9955 computer. Analysis was also made of the Practice Logs, and Weekly Practice Evaluations completed by participants.

Results

The results of this study can be divided into two categories. The first category deals with the results of the performance tests of the various groups. The results of these tests revealed the following:

1. There was shown to be significant difference between the groups at the .05 level for the period between the pretest and interim test 1. This difference favored the Motor Schema Theory (MST) Group. There was not shown to be significant difference between the groups for the periods between interim test 1 and interim test 2, or between interim test 2 and posttest 1.

2. The MANOVA showed significant differences between the groups for the entire eight-week experimental period. The level of significance of group assignment was shown to be .007. This favored the Motor Schema Theory Group. Thus, the null hypothesis was rejected for the test period. It can be shown that there were significant differences between the groups.

3. The results of the ANOVA on the results of posttest 2 did not show significant differences between the groups at the .05 level. Thus, it was not shown that the four-day practice period provided for
posttest 2 allowed for significant differences between the groups.

The second category of results is the response of the students to the materials utilized during the study. These were Form III-D: Weekly Practice Log, and Form III-E: Weekly Practice Evaluation. The purpose of these forms was to determine the weekly practice totals of the participants in the three groups, and to determine their feelings concerning the procedures and instructions used in the study. A secondary purpose of the forms was an attempt to encourage practice time by the participants, as well as encourage thought about procedures utilized.

The results of the data from these forms can be summarized as follows. In terms of practice amounts, the Motor Schema Theory (MST) Group reported higher amounts of practice than did the participants in the other two groups. This was due in part to the unusually high practice totals reported by one individual, whose weekly mean practice approached forty hours. However, even without this contribution, the MST Group reported generally higher practice totals than did the other groups. The lowest practice totals were reported by the Control Group. Although no attempt was made to determine why the Control Group practiced less, it might be surmised that the lack of regular group meetings was a contributing factor. Weekly practice amounts fluctuated considerably, both within and between groups. It was outside the limits of this study to determine the factors which caused these fluctuations, however.

Form III-E consisted of a series of ten statements to which the musicians were asked to indicate responses based
on a scale of 1 to 5, with 1 indicating strong agreement and 5 indicating strong disagreement. Again, MST Group members reported more favorable feelings concerning the procedures used, their formation of goals, the balance of mental and physical practice, and others. Control Group members reported less agreement with many of the statements than the members of the other groups reported. This was particularly true concerning a statement dealing with adequacy of practice time, which would seem to support their lower practice totals, as determined previously.

Conclusions

Based on the data presented in this study, a number of conclusions can be drawn. First, the motor schema theory of learning has been shown to have validity in the teaching of practice technique. The design of the study incorporated the motor schema theory into a plan of practice which combined more traditional practice techniques with those of this theory. The Motor Schema Theory Group, which received instruction in formation and use of the schema, demonstrated significantly greater improvement than did the other groups over the entire eight-week period of the experiment. The results strongly supported the possibility of increased efficiency through use of this theory, especially when combined in the manner in which it was used for this study.

It was not shown that the individual segments of instruction, as measured by the interim tests, produced significant differences between the groups. Only the period from the pretest to interim test 1 showed significant difference. It must be concluded that the differences apparent at the conclusion of the experiment
were due to the combined effects of the instruction, rather than to the individual segments.

Secondly, the data would seem to support the idea that the development of understanding of a rather complex theory such as this one takes a relatively long period of time. During the introductory phase of the motor schema theory, the mean scores of the MST Group actually declined slightly from those recorded on an earlier test. This could be attributed to possible confusion regarding the procedures for forming and using schema in practice. However, by the end of the instructional period, this group showed greater mastery of the material than did the other groups, indicating better acquisition of the theory.

Thirdly, students in the higher-contact groups reported generally greater amounts of practice, and greater levels of agreement with the statements of Form III-E. This can not be attributed to the teaching of the motor schema theory; however, it does suggest that increased instruction in practice technique can yield positive results. This could possibly be due to the Hawthorne effect, as well. There is some possibility that the participants in the higher-contact groups showed higher practice totals due to the perception that they were being more closely observed due to the increased meeting times which were not given to the Control Group.

It can be further concluded that the different methods of treatment in this study resulted in significant differences between the groups. It is likely that some of the participants in the Traditional and Control Groups were familiar with at least some of the information which was presented to the Motor Schema Theory Group. Since many of the participants had received applied instruction, it is
likely that some of this information had been acquired previously. However, the study did not attempt to measure the amount of learning of these concepts which had taken place prior to the study. The results of this study, therefore, do not conclusively show that the means of instruction which did not include the motor schema were inefficient. Instead, it was shown that this instruction was less effective than the motor schema instruction in this study.

Implications

A number of implications for the teaching of practice techniques can be drawn from this study. Some of these may be summarized as follows:

1. Efficiency in practice can be improved through a systematic method of instruction in practice techniques. Students should be given a thorough understanding of basic techniques similar to the traditional techniques described in Chapter 1 of this study. Following instruction in basic practice techniques, additional efficiency can be gained through instruction in the role of motor schema in practice and performance.

2. Specific motor movements used in musical performance can be stored in the coordinative structures. Some methods of developing these structures during practice could include:
   (a) Build from smaller to larger units. Early in the practice period (which might extend over several weeks), the student should work on small units, including isolated rhythms, small groups of notes, individual intervals, and similar items.
(b) Connect smaller units into progressively larger ones. Students should strive to link these units into more extended patterns. For example, individual notes could be linked into a scale, or a number of motives could be linked into a phrase. When performing these linked patterns, the performer would think of the appropriate scale, or the contour of the phrase.

(c) Avoid incorrect playing whenever possible. Schema (and habits) are formed and reinforced whenever practicing. Repeated practice of large segments of music early in the practice period can lead to the formation of schema for incorrect performance. These can then be invoked unintentionally during performance.

(d) Attempt to build as many links as possible between units. This promotes the development of varied schema. Students might practice from the middle of one phrase to the middle of another, build the phrase from the end backward to the beginning by practicing one measure at a time, or locate boundaries in the playing by noting when stops occur, or where errors occur.

3. The executive level gives general instructions to the coordinative structures. Images stored there are likely to be more general, as well. The executive level can be developed during practice by utilizing steps such as the following:

(a) Attempt to relate the material which is being practiced to previous learning by identifying scales, chords, or recognized patterns. This will make use of schema previously stored and provide possible links for forming new schema. For example, a passage might consist of portions of three different scales. By
relating it to the previously learned scale patterns, the passage might eventually be stored as a single entity with the observed features of the three scales. Thus, a new image would be formed, and stored at the executive level in a general way.

(b) Utilize a variety of images when practicing in order to develop as many schema as possible. Differing images result in differing schema, and differences in performance. For example, a phrase might be thought of by its melodic direction, its dynamic contour, its relation to surrounding phrases, or by the kinesthetic feel of playing it. Each of these could produce a different schema, resulting in differences in performance. Likewise, modeling another performer by listening to either live or recorded performances of the same material could produce other schema.

(c) Attempt to develop continually larger, more inclusive schema. This could be accomplished by linking phrases together into a section of a composition, by developing a kinesthetic or musical image which represents a larger segment of music, or by linking the musical elements (such as scales, chords, intervals, or dynamic contour) into a larger unit which represents a sizeable segment. In practice, students could work continually toward larger schema, controlled by the executive level.

4. Misfits occur when the feedback does not match the schema which have been stored during practice. These misfits could result in performance errors, memory lapses, feelings of discomfort, or performance anxiety. During the practice period, students could develop a variety of schema for performance. These might include
visualization of the performance situation or the location of the performance, anticipation of likely feelings during performance, and possible sources of tension or difficulty in performance. These could then be practiced mentally or physically, allowing for the development of schema to deal with them. Possible alternative schema to be used in performance could include concentration on the musical flow or musical ideas rather than on motor movements, location of boundary points which were planned during practice and would allow a return to the executive level, or implementation of a pre-planned sequence which would allow focusing on the executive level rather than on the distraction caused by the misfit. These sequences could include physical movements, mental images, or other images which would assist the performer in returning to the executive level as planned during practice sessions.

Recommendations

Based on the results of this study, several recommendations can be made. These can be summarized as follows:

1. More research should be done on the conditions of practicing, and increasing the efficiency of practice time. While numerous studies of practice have been done in the fields of physical education and psychology, very little has been learned regarding musical practice. It is uncertain whether information learned in other disciplines, such as physical education, is applicable to the field of musical practice. It seems clear that some of this information
is not applicable to musical learning.

2. The information gained in this study should be replicated in similar studies, utilizing different groups than those in this study. Many factors could be varied while seeking to discover if the conclusions remain valid. These would include size of the groups, constituency of the groups, age levels, methods of instruction, methods of testing, and other variances from the terms of this study. Since relatively little is known about either motor schema use or about practice techniques, the various combinations of these would seem to be very wide. For instance, a similar test using a large number of high school trumpet players in a number of different schools might show results which differ in some ways from those of this study. It is important to learn in which ways this information can be applied.

3. It is recommended that more research be instituted between the disciplines of experimental psychology and musical learning. It seems likely that there is much to share between the disciplines.

4. Teachers of applied music at the college level should do as much as possible to insure that students have a thorough understanding of practice techniques, and the benefits of various forms of practice. These should include physical practice, mental practice, problem-solving techniques, and instruction in the role of the psychological processes in practice technique.

5. The motor schema theory, with the provision of misfits, would seem to have promise in regard to managing nervousness and stage fright during performance. Research should be undertaken to
determine whether performers can be trained to stay more consistently at the executive level during performance, leading to fewer misfits, and perhaps less anxiety during musical performance. Anecdotal information from this study would suggest that this is a possibility. However, it was outside the limitations of the study to attempt to measure the effect of knowledge of motor schema upon the anxiety and nervousness level of the performer.

6. Another area which would seem to be possible for the study of the effects of the motor schema might be in techniques of memorization of music. A study could be designed which would test more traditional memorization techniques, including rote, in opposition to using schema formation as a memorization device. Several facets of the theory would seem to apply to memorization, including the building from small to larger units, the programming of the various levels of memory, and the desire to facilitate a sense of "automaticity" in the performance of memorized music. That is, the performer might desire to have the music become rather automatic. The study might measure the effect of motor schema programming on memory and retention of musical ideas.

7. A final area which might seem to have relevance to applications of the motor schema theory would be in the instruction and organization which takes place during musical ensemble rehearsals. Research could be designed which would attempt to determine if motor schema ideas could produce more efficient learning in rehearsal.
LIST OF REFERENCES


Spradling, R. (1979). The use of contingency contracting to increase the efficiency of practice time management in instrumental music majors. Paper presented at the National Association for Music Therapy National Convention, Dallas, TX.


APPENDIX A
Instructions to Etude A
Etude A
Etude B
APPENDIX A

INSTRUCTIONS TO ETUDE A

Do not take etude until you have assured that you understand these instructions.

1. Take one copy of the etude. You will be allowed a total of thirty minutes preparation time on the etude prior to testing. You may practice the etude in any way which you consider appropriate; however, you are not to mark or copy the etude in any way. You must sign the etude out, including the time which you received it. Also, you should not receive help from anyone in preparing or practicing the etude; the practice time is yours alone.

2. Upon completion of the thirty minute practice time, return to the test site. You will perform the etude, and will be tape recorded. At the time of your testing, you will be given an identification number. The adjudicators will not know your identity, other than this identification number.

3. When returning for testing, you must sign the etude back in, including the time of your return. You must return the etude to the test site; no one will be permitted to keep a copy of the etude.

4. After processing of the test scores, all participants will be assigned to one of the three experimental groups, and will be contacted regarding group meeting times and procedures.

5. If you have any questions regarding test procedures, practice procedures, or restrictions, please feel free to ask them. Do you understand these procedures as I have read them to you?
Etude A

(Note: Etude A has been reduced in size in order to meet margin requirements)
Etude B

(Note: Etude B has been reduced in size in order to meet margin requirements)
APPENDIX B
Instructions to Adjudicators
APPENDIX B

INSTRUCTIONS TO ADJUDICATORS

1. You will find enclosed a cassette tape recording of the performance test for the practice study. Although we have discussed individually the procedures to follow in adjudication, you will find a summary of them below.

2. On the written music provided, you will find an identification number, and the instrument on which the etude is performed. The etudes are presented to you in the same order in which they are on the tape.

3. For each performer, mark each measure in which you hear a mistake by placing a line through the measure. If there are multiple errors in the measure, it still will receive only one mark. The intent is to grade the number of measures played correctly.

4. The variables which you are to adjudicate are as follows:
   (a) rhythmic accuracy; (b) dynamic accuracy;
   (c) accuracy of articulation; and (d) accuracy of pitch. For item (d), I do not expect you to try to identify small errors in flatness or sharpness. Rather, we are evaluating the degree of conformity with the written score. Use your own musical judgement as to whether or not the note is played correctly. Use no mechanical or other devices to interpret small fluctuations in pitch; musically acceptable pitch should be the determinant.
5. When you finish marking the music, return it to me for compiling of the scores.

6. Please make no effort to identify any of the participants.

7. Thank you.
APPENDIX C
Weekly Outlines for Motor Schema Theory Group
and Traditional Group
Forms III-D and III-E
## APPENDIX C

### TABLE 21
Weekly Outlines: Motor Schema Theory and Traditional Groups. Weekly Subject List for Motor Schema Theory Group

<table>
<thead>
<tr>
<th>WEEK</th>
<th>SUBJECT</th>
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<tbody>
<tr>
<td>1.</td>
<td>Introduction: The goals of practicing; recommended methods for effective practicing.</td>
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<tr>
<td>2.</td>
<td>Isolating problems during practice; methods of problem solving.</td>
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<tr>
<td>3.</td>
<td>Setting goals for achievement; formation of long term and short term goals.</td>
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<td>PERFORMANCE EXAMINATION: THE GOALS OF PRACTICING</td>
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<td>4.</td>
<td>Introduction: Motor schema theory.</td>
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<tr>
<td>5.</td>
<td>Schema theory continued; the executive level and coordinative structures.</td>
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<td>PERFORMANCE EXAMINATION: SCHEMA THEORY</td>
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<tr>
<td>7.</td>
<td>Forming larger-scale schema; using different schema to achieve differing results.</td>
</tr>
<tr>
<td>8.</td>
<td>Using larger schema; review and summary.</td>
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<td>POSTTEST</td>
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TABLE 22

Weekly Outlines: Motor Schema Theory Group

WEEK ONE

I. Introduction.
   A. Purpose of the study.
      1. Ascertian the effects of instruction in practice behavior on the performance abilities of selected instrumental students.
      2. Measure results of three different methodologies of practice.
   B. Distribution and explanation of forms.
      1. Form I-A: Establishing goals for practice.
      2. Form I-B: Practice planning.
   C. Explain procedures for utilization of forms, importance of good record keeping.

II. Goals of practicing: Defining practice time.
   A. Maintain and improve musical skills.
   B. Achieve specific results: Physical, mental, musical.
   C. Mastery of various aspects of musical performance.

III. Establishing format for proper practice.
   A. Steps of musical learning.
      1. Formation of aural concept of what is to be achieved.
      2. Provisional tries.
      3. Reflection on what is right and wrong.
4. Decision on what changes should be made.

B. Steps in establishing practice format.
   1. Recognition that a problem exists.
   2. Isolation of, and work on, problem.
   3. Insertion of problem back into context.
   4. Reevaluation of original problem.

IV. Instructions for weekly practice.
   A. Use of practice materials (log and forms).
   B. Begin to consider goals for practice (What do I want to achieve?)
   C. Plan specific practice times for the week.

WEEK TWO

I. Identifying the problem.
   A. Internal, external, or mechanical identification.
   B. Initial readings to identify problem areas:
      Two suggested readings.
   C. Identify and mark technical, musical, other problems.
   D. Suggest utilization of outside source when possible to confirm problem identification:
      Teacher, listener, tape, etc.

II. Isolating the problem.
   A. What is the difficulty in this particular passage: Technical, musical, etc.?
   B. Various methods of developing skills to solve problem.
      1. Slow practice.
      2. Work from simple to complex.
      3. Change rhythms, speed, emphasis.
      4. Silent playing (form aural image).
      5. Supplementary exercises with similar patterns.

III. Inserting the problem back into original context.
   A. Put back into larger context; practice complete passage.
   B. Analyze possible difficulties in sections leading into or out of original passage.
   C. Continue to reinforce daily problems which are "solved".

IV. Reevaluation of problem.
   A. Has it been satisfactorily solved?
   B. Are there any other problems in this passage?
   C. What work, if any, remains to be done here?

V. Concepts for practicing.
   A. Slow practice.
   B. Long range planning.
   C. Short range planning.

WEEK THREE

I. Setting goals for achievement.
   A. Importance of long range goals.
   B. Relation of long range goals to practice planning.
      1. Work toward eventual goals.
      2. Have clear plan for achievement.
      3. Utilize daily work as preparation for eventual goals.
   C. Forming short term goals.
      1. Relating short to long term goals.
   D. How to set goals.
      1. Deciding upon goals.
      2. Establishing a time frame.
      3. Forming strategies to reach goals.
      4. Recognizing risks.
      5. Evaluation of progress.
II. Distribution and explanation of Form I-A: Establishing goals for practice.

III. Establishing a routine for effective practice.
   A. Warm up.
   B. Slurring, extensions in range.
   C. Interval work: Technique and ear training.
   D. Scales and technical studies in varying rhythms.
   E. Literature, etudes, designated studies.

IV. Introduction and explanation of Form I-B: Practice planning.
   A. Assignment: Develop a practice plan for each succeeding week of this study.
   B. Develop written plan of short term goals working toward long term goals established previously.

PERFORMANCE EXAMINATION: THE GOALS OF PRACTICING

WEEK FOUR

I. Schema Definition:
   A. Small set of generalized stored movements from which a larger, more specific set of movements can be drawn.
   B. Brain does not store specific, detailed instructions for every possible motor and muscle movement.
   C. Stores an abstract representation of a movement, and the possible consequences to it.

II. Examples of likely schema in every day life.
   A. Starting a car.
      1. Thought process is continual; does not identify each specific muscle movement or act.
      2. Process becomes almost "unconscious".
B. Walking.
   1. Done without conscious effort, in continuing fashion.
   2. Learning to walk: Trial and error, building from very specific movements to gradually larger ones. Smaller gradually become subsumed in larger ones.
   3. Final result is higher control: Generalized concept of "walk".

C. Producing given pitches on a musical instrument.
   1. At first, must learn specific muscle movements of lips, hands, arms, etc.
   2. Smaller movements become more generalized, lead into larger, more general ideas of movement.
   3. Final result is playing without (or with very little) conscious thought about specific movements which must be made.

D. Learning musical scale.
   1. Learn each note individually, perhaps even learning fingering, muscle movement necessary.
   2. Eventually become linked together into an abstract pattern called "scale".
   3. Recognition of pattern produces specific movements of pattern stored earlier.

IV. Assignment: Think about schema in your performance. Try to think of examples of times when you use schema in playing and in practice.

WEEK FIVE

I. Brief review of definition and examples of motor schema.

II. The two levels of storage in schema theory.
   A. Coordinative structures.
1. Definition: Secondary level of memory storage.
2. Storage of specific instructions for movements.
3. Execution is unconscious: Outside control of conscious thought.
5. Examples: Illustrate role of coordinative structures in examples used for week four.

B. Executive level.
1. Definition: Higher level which stores more abstract, generalized representation of desired physical movements.
2. More likely to store concepts and conceptual ideas, such as "scale", "embouchure", "walk", etc.
3. More conscious control of schema selected, resulting in slightly differing movements, interpretations, results.
4. Can also change in relation to kinesthetic feedback, or can select another schema which will fit better.
5. Examples: Illustrate role of executive level in examples used for week four.

III. Role of feedback in utilizing schema.
A. Actual movement is an interaction between the schema and the environment of the moment.
B. Changing feedback can change the schema, require alteration or selection of an alternate schema.

IV. Assignment: Read handout (pages 1–6 of chapter one, this study). Handout must be signed out, read in
controlled situation and returned. Participants are required to read material, and to sign.

WEEK SIX
I. Review of material and examples of previous two weeks.
   A. Answer questions arising from assignment.

II. Programming coordinative structures in practice.
   A. Build from small to larger units.
   B. Avoid incorrect playing whenever possible:
      Structures are being built whenever practicing.
      Information is being stored at both local and global levels.
   C. Seek to connect smaller units into progressively larger ones.
   D. Attempt to build many links between sections:
      Use different cues or ways of thinking about a section.

III. Programming executive level in practice.
   A. Attempt to build larger structures: Note to scale, scale to phrase, phrase to section, section to part of entire work, etc.
   B. Attempt to identify patterns within the music:
      Scale, chord, form of work, etc.
   C. Utilize practice plan to maximize results in building, recognizing and using schema in practice.

PERFORMANCE EXAMINATION: SCHEMA THEORY

WEEK SEVEN
I. Review and questions from weeks four to six.
II. Building larger schema.
   A. Building from measure to phrase.
1. Attempt to recognize outline of phrase: Direction, construction, musical intent, context.
2. Link a given phrase to others: Establish direction, relation between phrases, relation to piece as a whole.

B. Building from phrase to section.
   1. Recognize form of section.
   2. Relate phrases (individually and collectively) to section.

C. Building from section to larger segments.
   1. Recognize form of entire work or larger section.
   2. Relate section to overall work, or larger section.
   3. Attempt to establish many links between phrases, sections, portions of overall work.
   4. Recognize repeated sections, or repetitions with slight variations within them.

III. The role of "misfits" in schema and performance.
   A. Definition: Places where the feedback does not match the previously stored information, or schema being used.
   B. Examples of possible misfits:
      2. Changed performance situation: Unfamiliar feedback.
      3. Sudden or unexpected change from executive to local level.
      4. Uncomfortable feel, or thought process, while performing.

IV. Assignment: Plan in practice to move from smaller to larger segments and form larger schema. Use Form
I. Review: Building larger schema, definition of "misfits".

II. Planning for misfits in practice.
   A. Build a large variety of schema, so it is easy to move from one to another.
   B. Recognize places where misfits are more likely to occur.
      1. Ends of phrases.
      2. Links between various sections, or parts of larger work.
      3. Key changes, meter changes, etc.
   C. Practice by building across these spots.
      1. Practice from middle of one phrase to middle of another.
      2. Mentally regroup phrases, sections, etc.
      3. Practice endings, transitions, repetitions.
      4. Build differing schema for repetitions with slight variations.

III. Summary and review of eight weeks.

IV. Posttest.

TABLE 23

Weekly Outlines for Traditional Group

WEEK ONE

I. Introduction.
   A. Purpose of the study:
      1. Ascertain the effects of instruction in
practice behavior on the performance abilities of selected instrumental students.  
2. Measure results of three different methodologies of practice.

B. Distribution and explanation of forms to be used.
   1. Form I-A: Establishing goals for practice.
   2. Form I-B: Practice planning.

C. Explain procedures for utilization of forms, importance of good record keeping.

II. Goals of practicing: Defining practice time.
   A. Maintain and improve musical skills.
   B. Achieve specific results: Physical, mental, musical.
   C. Mastery of various aspects of performance.

III. Establishing format for proper practice.
   A. Steps of musical learning:
      1. Formation of aural concept of what is to be achieved.
      2. Provisional tries.
      3. Reflection on what is right and wrong.
      4. Decision on what changes should be made.
   B. Steps in establishing practice format:
      1. Recognition that a problem exists.
      2. Isolation of, and work on, problem.
      3. Insertion of problem back into context.
      4. Reevaluation of original problem.

IV. Instructions for weekly practice.
   A. Use of practice materials (log and forms).
   B. Begin to consider goals for practice: "What do I want to achieve?"
C. Plan specific practice times for the week.

WEEK THREE

I. Identifying the problem:
   A. Internal, external, mechanical identification.
   B. Initial readings to identify problem areas:
      Two suggested readings.
   C. Identify and mark technical, musical, other problems.
   D. Suggest utilization of outside source when possible to confirm problem identification:
      Teacher, listener, tape, etc.

II. Isolating the problem.
   A. What is the difficulty in this particular passage: Technical, musical, etc.?
   B. Various methods of developing skills to solve problem.
      1. Slow practice.
      2. Work from simple to complex.
      3. Change rhythms, speed, emphasis.
      4. Silent playing (form aural image).
      5. Similar supplementary exercises.

III. Inserting the problem back into original context.
   A. Put back into larger context, practice complete passage.
   B. Analyze possible difficulties in sections leading into or out of original passage.
   C. Continue to reinforce daily problems which are "solved".

IV. Assignment: Identify a problem in practice, and apply one of the specific methods identified above to solving it.
WEEK FIVE

I. Review: inserting the problem into original context.
   A. Put back into larger context, practice complete passage.
   B. Analyze possible difficulties in sections leading into or out of original passage.
   C. Continue to reinforce daily problems which are "solved".

II. Reevaluation of problem.
   A. Has it been satisfactorily solved?
   B. Are there any other problems in this passage?
   C. What work, if any, remains to be done here?

III. Concepts for practicing.
   A. Slow practice.
   B. Long range planning.
   C. Short range planning.

WEEK SEVEN

I. Setting goals for achievement.
   A. Importance of long range goals.
   B. Relation of long range goals to practice planning.
      1. Work toward eventual goals.
      2. Have clear plan for achievement.
      3. Utilize daily work as preparation for eventual goals.
   C. Forming short term goals.
      1. Relating short to long term goals.
   D. How to set goals.
      1. Deciding upon goals.
      2. Establishing a time frame.
      3. Forming strategies to reach goals.
4. Recognizing risks.
5. Evaluation of progress.

II. Distribution and explanation of Form I-A:
Establishing goals for practice.

III. Establishing a routine for effective practice.
   A. Warm up.
   B. Slurring, extensions in range.
   C. Interval work: Technique and ear training.
   D. Scales and technical studies in varying rhythms.
   E. Literature, etudes, designated studies.

IV. Introduction and explanation of Form I-B:
Practice planning.
   A. Assignment: Develop a practice plan for each succeeding week of this study.
   B. Develop a written plan of short term goals working toward long term goals established previously.
Form III-D
WEEKLY PRACTICE LOG

Week of: __________ Name: _______________________________________

Day Amount of time Procedure

1.

2.

3.

4.

5.

6.

7.
Form III-E

WEEKLY PRACTICE EVALUATION

Instructions: For the following statements, choose the response which best describes your thoughts and feelings during this week's practice. For any response which does not apply to you this week, please place an "X" through the statement number. Otherwise, please mark a response for each statement given. The scale utilized is as follows:

1- Excellent/ Strongly Agree  
2- Good/ Agree  
3- Average  
4- Below Average/ Disagree  
5- Poor/ Strongly Disagree

1. This was an effective week of practice for me.
   1 2 3 4 5

2. I understood the goals of this week's practice.
   1 2 3 4 5

3. My goals for this week were reasonable and achievable.
   1 2 3 4 5

4. I understood the procedures utilized for this week's practice.
   1 2 3 4 5

5. My overall practice time for this week was adequate.
   1 2 3 4 5

6. My practice time displayed a balance between mental and physical practice.
   1 2 3 4 5

7. My goals for this week built logically on past work, and lead logically toward future work.
   1 2 3 4 5

8. I think that I am making steady progress during my practice time.
   1 2 3 4 5
9. My practice time this week utilized efficient practice procedures. 1 2 3 4 5
10. I see clear, positive results from this week's practice. 1 2 3 4 5
Comments: In order to fully understand your responses to the statements on the previous page, commentary will be helpful. Please give written comments for any statement which allows you to do so. Comments concerning your efficiency, practice procedures, areas of uncertainty, or anything else which has arisen this week, or continued from a previous week would be helpful. Use this sheet for your comments, and attach a second sheet if necessary. Your cooperation is greatly appreciated.
APPENDIX D

Selected Comments from Form III-E

Practice Evaluation
APPENDIX D
Selected Comments from Form III-E

WEEK ONE
1. "I think some time was wasted by playing through and not working to correct each problem."
2. "Too busy. Procedure wasn't clear until late in week."
3. "This week of practice was not very effective because my mind was not on the music and I was not organized."
4. "My practice procedure has always been to read the piece without playing it first, work the fingers through, and then add the air or sound. It seems to work when I practice."
5. "Normally I don't set "goals" for practicing. I just play and let things naturally happen."
6. "Most of my practicing, especially on the purely technical stuff, has been mainly physical . . . ."
7. "I feel I am not making as evident progress if I concentrate on such small segments . . . . I want to make the most of my time."

WEEK TWO
1. "I used the slow practice technique which did help me concentrate on problem areas better. They become more obvious for me to then isolate to work on."
2. "Effective week. Understood the procedures. Accomplished goal."
3. "Often I play pieces for cello just to push myself to practice at all. I choose selections which are in the same key as my lesson materials to get both my fingers and ears warmed up. Is this an example of mental and physical?"
4. "I think my practice this week was very good. I worked on rhythm, tone and dynamics, as well as finger passages."
5. "Mental practice usually occurs right after or right before 'real' practice."

WEEK THREE
1. "I found I wanted to use slow practice (last week's technique) instead of playing silently . . . I can hear the trumpet part easier to practice silently, but not keyboard so easily."
2. "Slow Practice seemed to work."
3. "My technique . . . is really beginning to come together, due to increased amount of practice time. I'm now to the point where I don't feel like I'm cramming for a lesson—I feel like I'm prepared and on top of things. I'm now using my practice time more fully."
4. "The main thing that has helped me out in practicing this week is listening . . . I set concrete goals for this week (expression, dynamics, phrasing) which were accomplished."

WEEK FOUR
1. "The specific way to practice was none of those listed: I merely repeated everything again and again. I did, however, isolate a few trouble spots to work out."
2. "When I go into my lessons, now it seems as though I have a firmer ground to fall back on. My lessons are more completely prepared. Also, I'm not getting bored in the practice room."
3. "I didn't have the desire to practice. I had to force myself to come down here. My mind wasn't on my work."
4. "I do see improvement in working out rhythms and counting."
5. "My rehearsal was aimed mainly towards an Easter performance."

WEEK FIVE
1. "... Practiced tough spots of the Latham daily-working for tone and consistent range ... I did work on some Arban triple tonguing and it helped."
2. "Silent practice didn't do a whole lot for me. I think that I need to be hearing the music to be successful."
3. "I wanted to practice. I set my goals before the week started and achieved most of them."
4. "Everyday (sic) practice enforces lesson knowledge and technique, helps with my counting, and gives more self-confidence."
5. "... basically a week of last-minute brush-ups on performance pieces."

WEEK SIX
1. "Practice time was below normal because of Friday and Saturday's misses when I confined myself to my room beside the phone."
2. "Review period in which I feel I reinforced what I already knew."
3. "I discovered what a truly valuable help a tape player is when practicing. I pick up mistakes that I gloss over when practicing, and I also find problem spots that I didn't realize existed."
4. "In any situation you need a positive response to your work to keep you going on practicing."
5. "I wish I could concentrate more on my practicing."
6. "While I didn't do much in the way of mental practice, the physical practice I did accomplished something."
WEEK SEVEN
1. "I worked on scales mostly, so I was concentrating more on specific technique . . ."
2. "Slow practice worked better than silent practice. I think it helps to hear the part instead of just fingering through it silently."
3. "Considering—it must be that wonderful schema at work, taking familiar things and applying them to the unknown."
4. "My mood was one that nothing could upset me."
5. "... Probably the best week—the only week this year that I got in that much time. I'm working towards memory in all my practice time right now . . ."

WEEK EIGHT
1. "I understand the concept and theory of schema. I never knew what to call it but knew it was there. It's easier to concentrate and practice better because I understand the reasoning behind my exercises. I got out of the practice room a few times and 'simulated' a performance . . ."
2. "This week spirits were pretty high. Practice time was efficient for me."
3. "It was a good learning experience and I think that I've cleaned up in technique, etc., since we've started."
APPENDIX E
Test Scores
# APPENDIX E

## TABLE 24
Test Scores

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Note: Scores shown are averages of the scores from the two evaluators.