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THE EFFECT OF MODELING AND TEMPO GRADATIONS AS PRACTICE TECHNIQUES ON THE PERFORMANCE OF HIGH SCHOOL INSTRUMENTALISTS

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy in The School of Music

by

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ABSTRACT

The purpose of this study was to examine the effect of modeling conditions and tempo gradations as practice techniques on the performance of high school instrumentalists. Specifically, the independent variables of this study were model versus no model; and steady increase of tempo versus performance speed tempo versus alternating (slower and faster) tempos. Subjects (N = 60) were high school wind instrumentalists from the Midwest and the South. Subjects sight-read an etude, practiced the same etude six times using one of six distinct practice conditions, which were combinations of the two independent variables, and performed a posttest on the same etude. Dependent measures were pre-posttest gain score comparisons of percentages of correct pitches, rhythms, and articulations, as well as overall percentages of tempo gains. Results demonstrated the With-Model condition to be superior to the No-Model condition in Rhythm Percentage Gain and Tempo Percentage Gain. Tempo Gradations had no significant effect on results.
INTRODUCTION AND STATEMENT OF THE PROBLEM

Music performance involves both artistic expression and disciplined technique. Before music performance as artistic expression can be enjoyed, disciplined technique must be developed. Schwadron (1967) noted the kinds of disciplined experiences that are preparatory to artistic musical performances.

The necessary drilling on isolated choral or instrumental parts, the introduction by means of pictures and sounds to orchestral instruments, or the isolated practice on a second clarinet part are all preparations for some higher (aesthetic) end. (p. 9)

Such drilling is also mentioned in the work of Alfred North Whitehead. In The Aims of Education and Other Essays, Whitehead analyzed education through three stages: the Stage of Romance, the Stage of Precision, and the Stage of Generalisation.

The stage of romance involves novelty. When new material is presented, possible connections are being constantly made, and “knowledge is not dominated by systematic procedure,”(p. 17). Learning is exploratory in nature. Whitehead sums this stage:
Romantic emotion is essentially the excitement consequent on the transition from the bare facts to the first realisations of the import of their unexplored relationships. (p.18)

Once the initial Stage of Romance is finished, the Stage of Precision is entered. Here, the learner adds to his/her knowledge. In this stage, the “width of relationship is subordinated to the exactness of formulation,” (p. 18). Facts are acquired in a systematic order and added to the initial knowledge garnered in the Stage of Romance. The overriding goal of the Stage of Precision is to acquire the knowledge necessary for the synthesis that allows passage to another romantic stage, the Stage of Generalisation.

The Stage of Generalisation is somewhat of a return in emotion to romance, yet this romance is heightened by newfound abilities coming from the Stage of Precision. Whitehead calls this the “final success,” and it is similar to the aesthetic feeling that performers experience when artistic effort, honed by hard work, meets perfectly with emotion.

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Jourard (1968) further explained the necessity of skill development (Whitehead's Precision) in the pursuit of artistic excellence:

One can have an artistic consciousness and be a poor craftsman, unable to transmute a memory, imagination, fantasy, or thought into the possibility of a perceptual, recollective, emotional, or imaginative experience in another person. Unless the artist produces, and produces artfully, he is only an artist in his consciousness, an artist-for-himself. He only becomes an artist-for-others when he externalizes his experience, embodies it in some idiom—words, paint, clay, sounds, the movements of the dance. (p. 177)

Thus, it seems that, in providing schooling for artistic music performance, music educators must determine the best procedure for developing disciplined technique. The question then is, "What is the most effective way to acquire the technical expertise necessary to create an artistic musical performance?"

Fitts and Posner (1968) break the learning of a motor skill into three separate stages. First, the learner simply tries to understand the task at hand. During this early, cognitive stage, the learner typically attends to cues, responses, and events that later become an unnoticed part of a longer chain. Teaching in this stage is largely focused on successive approximation. The second stage is called the intermediate
(or associative) stage. Here the learner focuses on specific skills and practices them. This leads to the final stage, where long chains of events are not under scrutiny of cognitive control. Actions become more "natural," and skills require less processing. It is in this stage that the musician experiences what Wilson (1951) refers to as the "chief joy of practice...the opportunity for self-expression" (p.28). It is in this final state that the musician can attend to the aesthetic qualities and aesthetic aspects of a piece of music. It is this stage that music educators need to reach with their students as efficiently as possible. Elliot (1995) summarizes the importance of this:

Properly understood, then, practicing involves contextual repetitions: continual rethinking in relation to intended goals. Practicing is not mechanical duplication. As errors are detected and corrected and as problems are found and solved, difficulties diminish and parts are linked to large wholes. All this requires attention, awareness, and memory. (p. 289)

Thus, practice is seen as a series of successive approximations. Each approximation leads the musician closer to the final product, an aesthetically pleasing performance for the performer and listener. Practice techniques recommended by music educators fit the stages of motor skill learning outlined above by Fitts and Posner and Elliot.
First, students need to understand the intended goal and the task at hand. Toward that end, music teachers may provide recordings of high quality performances as models. Rosenthal (1984) studied the effects of models on the performances of advanced instrumentalists and concluded that listening to a model alone, without opportunity for practice, might be as effective as practicing with the instrument in hand. Thus, modeling might be considered one of the most efficient means of reaching attainable goals in music.

Second, students need to focus on particular skills and practice them. Band directors and orchestra conductors often adjust tempos during the initial music learning stages to foster mastery of a given piece's technical demands. Results of research on the effect of tempo variation on musical performance demonstrate mixed results. To achieve success in this second stage, some teachers and researchers recommend practicing at a slower tempo (Bruser, 1998; Sitton, 1992; Barry & McArthur, 1994). Others outside of the field of music hold that training specific to the task, that is, training at the target tempo, is most effective (Dunham & Kell, 1980; Henry, 1958; Hutton & Atwater, 1992). Donald (1997) advocated practice tempos that alternate between slow and fast to facilitate learning.
Previous research in music practicing techniques has primarily focused on both advanced and beginning instrumentalists. Modeling was shown to be an effective music learning tool for beginners (Zurcher, 1975; Puopolo, 1971) and advanced instrumentalists (Rosenthal, 1984; Rosenthal, Wilson, Evans, & Greenwalt, 1988).

The purpose of this study was to study the effect of modeling and tempo gradations as practice techniques on the performance of high school instrumentalists. Specifically, the independent variables of this study were model versus no model and steady increase of tempo versus performance (target) tempo versus alternating (slower and faster) tempos. Dependent measures were gain score percentages of correct pitches, rhythms, and articulations, as well as overall tempo gains.

The following review of literature will focus on studies in music and other fields requiring motor skill development where practice has been an independent variable. Additionally, studies of the use of tempo variation and modeling to improve music performance will be examined.
REVIEW OF LITERATURE

General Overview

Many different approaches to practicing are recommended by various teachers and performers. Among non-research based writings are magazine articles (Combs, 1985; Sitton, 1992; Yarrison, 1993), theoretical essays (Hedden, 1981; LaBerge, 1981; Restle, 1981; Sidnell, 1981), and books of helpful practice ideas (Bruser, 1998; Snitkin, 1988). Further, performance-oriented studies involve the development of specific practice regimens on specific pieces of music (Thompson, 1986; Perementer, 1997). None of the above systems or regimens was tested experimentally.

Zdzinski (1991) reviewed literature dealing with motor learning and its applications to music education. Zdzinski notes that gross motor skills do come into play in marching bands and dance situations, but the typical rehearsal setting of concert bands and orchestras revolves more around fine motor skills such as finger technique and lip manipulation.

Zdzinski's review of articles on motor learning found that: (1) mental practice combined with physical practice produced superior results to any other combination of practice forms; (2) feedback
studies have found inconclusive results as to feedback's effectiveness; (3) modeling behavior can be an effective means of transfer of motor skills; (4) the age of the subject is an important factor in the effectiveness of modeling; (5) different learner characteristics have a decided impact on the results of motor learning transfer; (6) motor ability can be a predictor of future success in instrumental music; (7) motor learning instructional techniques have been found to increase performance ability of instrumentalists; and (8) distributed practice is more effective than massed practice.

Zdzinski concludes that some principles of motor learning, such as mental practice and distributed practice, can be applied to instrumental music education settings to facilitate learning. Further, fine motor research indicates that the effect of modeling differs with age. Implications here are presenting the model prior to task presentation for younger students while utilizing a model further in the learning process to aid refinement for older students. Zdzinski also concludes that these principles have much to offer students and teacher in an instrumental music education setting. The author concludes that, "much more research is needed to fully understand the
relationships between motor learning, music learning, and musical performance." (p. 201)

This sentiment is echoed in a review of literature by Turner (1998), who used a body of elementary physical education research to answer elementary music education questions. The format took a question-and-answer format, which facilitated understanding. Suggestions from this review are (a) feedback (knowledge of results) should be given in a manner similar to a variable ratio scale to be most effective; (b) children remember information longer if the information is taught in context (that is, with several other things at once); (c) teaching children cognitive strategies can aid in the learning of new skills; and (d) a variety of models improves retention in children.

Zdzinski and Turner used research from outside the music education area. It stands to reason that if much of music learning deals with motor skills, then those outside of music and music education may have valuable insight as to effective means of learning specific skills. Fitts and Posner (1968) state that frequent repetition within short periods of time is a less effective means of mastering fine motor skills than the same amount of repetition with more frequent rests. Wild and Payne (1983) concur with their experiment results.
Researchers outside of music have attempted to ascertain the reason for the lack of correlation between practice time and performance achievement. One theory, called the Inhibition Theory, assumes that the act of responding creates a negative motivational influence. This theory explains the inefficacy of massed practice by postulating that the negative motivational influence builds to the point where tendencies reinforced through practice are suppressed by the burden of this negative force. Resting will cause the negative force to subside, allowing for a greater rise in performance level. Wild and Payne (1983) reinforced this theory with a study of 80 subjects under four different practice conditions. A pursuit task was used as the dependent variable, with one-minute practice sessions spaced apart at constant, gradually increasing, or gradually decreasing inter-trial intervals. Results showed that increased inter-trial intervals resulted in greater ability to learn. Implications were that the amount of negative motivational influence subsided in relation to the amount of rest; thus, increased rest between short practice sessions will aid in learning a fine motor skill due to motivational factors. If this is the case, then it stands to reason that effective practice in the time allotted becomes ever the more important.
In music education research, approaches to practice have been studied primarily using descriptive methodology. Bernard (1990) studied the practice habits of university trumpet instructors. Results of this survey indicated general agreement on the materials used in a daily practice routine, although no set amount of time for practice was mentioned.

Barry (1991) studied attitudes toward practicing among 120 high school seniors and 24 professional musicians. Data indicated that both professionals and students enjoyed music practice, approached practice in a systematic and planned manner, practiced with specific goals, marked their music, and occasionally looked up unfamiliar definitions. Significant differences were noted in that professionals more often read background information on pieces than did students. Most significantly, professionals were much more likely to use a metronome and practice at slower tempos. Barry noted that this finding supported other practice literature indicating that slow, deliberate practice and practice with a metronome are efficient and effective when compared with practice at faster tempos and practice without the use of a metronome.
Another investigation (Barry & McArthur, 1994) indicated that, although professional studio teachers and college-level instructors stressed the importance of practice in general, few specific techniques were given to students regarding how to practice. Results also indicated that college teachers differed significantly from studio teachers in the types of teaching strategies used. Specifically, college level teachers were less likely to require students to follow a specific practice format, give written practice formats to follow, insist that students begin a piece slowly and gradually increase the tempo, and involve parents.

In another descriptive study by Hallam (1995), free-lance musicians (N = 22) were interviewed in order to ascertain practice behavior. Subjects differed in the amount of time spent practicing, scheduling of practice, motivation (internal or external) for practice, approaches to learning specific pieces of music, and the means of developing overall technical facility. One of the few concepts receiving a consensus from subjects was the general need for practice efficiency. Hallam offered live and recorded models as one possible means of increasing practice efficiency.
These findings are supported by a study of instrumentalists who are still training (Hamman, Lucas, McAllister, & Teachout, 1998). This investigation focused on practice routines in an attempt to reduce the number of variables necessary to describe the phenomenon of university student practice. A questionnaire was presented to 711 university music students at three medium-to-large state universities in Indiana, Ohio, and Pennsylvania. Data analysis yielded six category factors contributing to university student practice routines: Internal Satisfaction, Practice and Conflicts, Practice Organization, Physical/Mental Limitations, Practice Stamina, and External Influences. The authors suggested that external influences are not as significant as internal satisfaction in motivating students to practice. Pertinent to this study is the extreme variability of responses. These six categories are very broad, yet they account for about three-quarters of the factors influencing practice routines among university students. This kind of variation led Barry and McArthur (1994) to state, "Music students must practice to achieve musical growth and progress, but not all practice is effective" (p. 53).

The lack of relationship between practice time and achievement is echoed in the work of Sloboda and Howe (1991, 1991a) who found
that the best young musicians may or may not have practiced more than their peers in early training. In the interview of 42 students and their parents at a prestigious English music school, it was found that many (39 of 42) needed some form of parental encouragement to practice. In later years, most subjects internalized the desire for practice.

A similar investigation was done by Bloom (1985), who studied 21 of the most prestigious concert pianists in the world. He determined that approximately 16 years of study were required for the achievement of excellence in music performance. Bloom also noted that expert musicians typically practiced 25 hours per week during adolescence and increased the amount of practice to approximately 50 hours in adulthood. In spite of this, reports varied greatly as to the amounts of practice that were used while in childhood and adolescence. Some practiced constantly, while others practiced only as much as their parents, guardians, or teachers insisted. One constant seems to be the large amount of attention shown these youngsters due to their piano proficiency.

An earlier study by Wagner (1975) demonstrates this concept experimentally. This study emanated from the curiosity generated
when students who have not practiced have "good lessons" while some students having "bad lessons" have been practicing diligently. Wagner’s assumptions were that practice should make musical performance better, if not perfect, and that accurate practice records must be kept if the effect of practice time is to be accurately considered.

The study took place over an eight-week academic term and involved 48 subjects divided into four groups. The first group turned in practice reports for the entire eight weeks. The second group reported practice on weeks 1, 2, 5, and 6. Group three turned in practice reports during weeks 5 and 6. The fourth group served as a control group and turned in no reports.

Subjects chose their own music for pretests and posttests. The first 90 seconds of the performances were recorded. Results showed that all groups improved from pretest to posttest conditions. No significant improvement differences were recorded from any of the groups. An investigation of weeks 5 and 6 (the time when all experimental groups were reporting practice time) showed a significant difference between groups in the amount of documented practice time. Specifically, the third group documented significantly more practice.
time than the first two groups. The first and second group did not differ significantly. Since no significant differences were found in the test scores, the data led the investigator to state, "It would seem then that the amount of time practiced is not the only determining factor in music improvement." (p. 130)

Although the above research shows a general lack of consensus in amount of practice, practice organization, and preferred practice technique, a few basic principles seem to permeate much of the descriptive data. Tempo adjustment, metronome use, and initially determining the music's overall structure seem to be more prominent among accomplished instrumentalists. Experimental research in practicing furthers this line of thinking, suggesting strategies to possibly facilitate more effective practicing.

One line of research in practicing involves mental practice. Zdzinski (1991) suggested that mental practice might be one of many ways to facilitate motor learning in music. Ross (1985) showed a combination of mental and physical practice to be statistically equal in effectiveness to physical practice alone and superior statistically to no practice and mental practice alone.
These results are consistent with those found in a study involving fifth graders with a single year of playing experience (Vander Ark, 1997). In this investigation, 80 subjects spent 20 minutes practicing a 16-measure etude. Results showed that physical practice alone showed no significant improvement while mental practice, physical practice with singing, and mental practice with simulated physical practice all resulted in marked improvement.

Lim and Lipman (1991) studied mental practice and its relationship to memorization of piano music. Results showed physical practice alone to be superior to mental practice with a model. However, these results derive from a small sample size ($N = 7$) and a wide inter-judge reliability range.

Mental practice was the focus of a review of literature by Brooks (1995). Brooks begins this review by citing work from the field of sports psychology, which has used mental practice and mental imagery since the 1960’s. Mental practice has been used to facilitate learning in a wide variety of activities, including basketball, darts, arc welding, and swimming. Brooks offers a broad musical definition of mental practice, which includes modeling, and offers some points of general agreement in music and non-music research that may be of some
benefit to the music teacher and student. Among these are (a) mental practice is best combined with physical practice; (b) short mental practice sessions best maintain concentration; and (c) mental practice is affected by task experience. Brooks recommends that models not be used as the sole teaching technique of music educators.

Coffman (1990) tested three types of practice, as well as knowledge of results, on piano performance. Subjects were 80 music education and music therapy majors who were not keyboard majors. Subjects were divided into four groups: physical practice, mental practice, alternating physical and mental practice, and reading (control). Each of these four groups was then further divided in half. One half was able to hear the electric keyboard that they were playing; the other half did not hear the results, as the speaker was disconnected.

Post hoc analysis of the results indicated that all three practice groups differed significantly from the control (reading) group. Physical practice alone and physical practice combined with mental practice did not differ significantly from each other and were found superior, statistically, to mental practice. The presence or absence of aural results did not make a significant difference in the final result. The
results further emphasize the need for some type of physical practice for optimal music learning.

Coffman's results differ from those of Havlicek (1969), who found that delayed feedback subjects executed significantly more errors in keyboard performance than synchronous feedback subjects. Studies of classroom teaching by Yarbrough (1987) and Price (1992) show the effectiveness of feedback in teaching. In his review of the literature, Zdzinski (1991) found mixed results for feedback on psychomotor skill development.

Structure of practice sessions is one concept that seems to prove effective in several different studies. Covey (1990) lists the first of "seven habits of highly effective people," as beginning with the end in mind. Goal-directed behavior is typically more efficient than behavior without preconceived goals. Results of studies may be significant solely due to structure of sessions. In one such study, Barry (1990) looked at the effect of a teacher-made practice structure, a student self-designed practice structure, and free practice on musical improvement. Subjects (N = 84) were participants in a summer music camp for high school-age students. They were divided into three equal groups and chose their own music for the experiment. The teacher-
made practice structure was a consensus of the recommendations of fourteen music instructors. Steps to be followed were detailed to subjects in this group during a 15-minute orientation session. Students in the self-designed group were given helpful guidelines but not a set practice regimen. These subjects were told to simply make their own practice regimen and follow it. Students in the free practice group were simply told to practice as they felt. All subjects had two, 15-minute practice sessions spaced one day apart.

Results indicated that, in terms of pitch and technique scores, those in the teacher-structured group fared better than the student-structured group and the free practice group. Furthermore, subjects in the student-structured group scored better than the free practice group. All differences were statistically significant. Similar scores, although not statistically significant, were observed for rhythmic accuracy and a subjective musicality score. This study indicates that some form of practice structure will enhance music learning; however, the specific activities within that structure have yet to be determined experimentally.

Barry (1992) investigated the effects of practice conditions, field dependence/field independence, and gender on musicality and
technical accuracy. In this two-week experiment, summer camp participants (N = 57) performed a taped pretest of an etude. Subjects in the structured practice group were told to practice the etude in a prescribed manner for a given length of time with an adult present, while subjects in the free practice group were simply told to practice the piece for a given length of time. This continued for three sessions. For the posttest, subjects were given five minutes to practice their piece and then tape-recorded.

Results indicated a strong two-way interaction between practice group and gender. Results also showed a strong three-way interaction between practice group, gender, and field dependence/field independence. In all cases, the structured practice group scored significantly higher. Barry interpreted these results to indicate that an organized, goal-oriented regimen of practice utilizing slow rehearsal, distributed practice, and mental practice is more effective than unstructured free practice as a means of improving performance.

In an individual music setting, Puopolo (1971) experimented with self-instructional practice materials to ascertain the effect of a strongly structured, yet individual, practice approach on achievement. Each weekly lesson was tape recorded and given to students. Tapes
included a model of the proper sound, piano accompaniments, and verbal instructions. Subjects were 52 male beginning trumpet and cornet students. A pretest-posttest format showed that achievement increased with the programmed individual instruction, and achievement gain was inversely related to intelligence quotient. Furthermore, students greatly preferred the structured practice setting.

Owen (1988) also studied the effects of free practice, practice technique instruction, and practice technique instruction with motor schema theory\(^1\) on the dependent variable of musical improvement. Subjects (N = 24) were divided into the three experimental conditions. All subjects kept practice logs and weekly practice evaluations that were returned to their respective teachers. Results showed significant differences in group improvement, with the motor schema group showing the greatest improvement. The motor schema group also practiced more than the other groups. Owen concluded that increased instruction in practice techniques (specifically with motor schema theory) is a valid tool for positive musical results.

\(^1\) Motor schema theory holds that copies of actual movements are not stored in memory, but rather ideas of relationships (schema) are stored that can be used to produce different, but related movements.
A similar investigation used motor schema theory to aid musical development of Suzuki violin students. In this experiment, by Pacey (1993), a series of three (weekly) performance observations were taken from a total of 47 students. Students were then subjected to a variable practice technique designed to increase recall schema. This variable practice technique included verbal instruction, group playing, solo playing, and marking bows in quarters with chalk. Beginning with the fourth observation, a noticeable difference in performance accuracy was documented. Pacey noted that variable practice seems to be most effective for those who know little or nothing of the desired skill and successingly less effective for those at various stages of acquiring the desired skill. In fact, the study shows that variable practice may be detrimental to those who have already mastered the skill. The investigator concluded by suggesting that music teachers vary their teaching techniques in class and send expectations for home practice that change, allowing for more variation.

One advantage of a structured practice session may be that students tend to prefer this type of practice session (Puopolo, 1971). Another of the advantages to a structured practice setting may simply be a more acute focus on the goals for a particular session. Madsen
and Geringer (1981) focused on attentiveness in practicing by utilizing a distraction index, which involved subjects writing down all distractions they encountered while practicing. University students (N = 24) were given practice distraction indexes at the beginning of an eight-week academic term while 24 served as a control group. Subjects performed a pretest and a posttest. Additionally, a complete reversal (ABAB) design was used on the experimental group. That is, they were given distraction indexes in weeks 3, 4, 7, and 8 and had no distraction indexes in weeks 1, 2, 5, and 6. Data showed that distractions increased between weeks 3 and 4 for the experimental group but remained constant in the second experimental condition (weeks 7 and 8). Also, the distraction index served to increase observed attentiveness, and, finally, performance scores for the experimental group were significantly higher than those in the control group. Madsen and Geringer suggest that the distraction index helped the experimental students internalize a higher standard of practice attentiveness.

Although focus of effort and structure of session are seen as conducive, if not necessary, to efficient music learning, just how to focus effort and just how to structure a practice session is not directly
addressed specifically in the previous music literature. The following sections deal with modeling and tempo adjustment as two possible structural components to facilitate music learning.

**Modeling**

Quite possibly the most well-known modeling advocate was Shinichi Suzuki. In his book, *Nurtured by Love*, Suzuki (1969) gave a philosophical account of the importance of modeling in music learning using the analogy of speech learning. Since every student knew how to speak even the most difficult of Japanese dialects, Suzuki postulated that no speaking child was without ability to imitate. Thus, musical imitation, like language imitation, became the foundation of his then-new teaching method, Talent Education. LaBerge (1981) also used a language analogy (both reading and speech) to analyze the relationship between motor skills and music. However, LaBerge differentiated between music learning and language learning in that music is prepared by rote to the point where the end product is predictable. In comparison, speech is not normally practiced in this way and is more spontaneous.

Sang (1987) listed four skills that are necessary for effective modeling: (1) the teacher's ability to demonstrate basic musical
performance behaviors; (2) the demonstration of the subtler aspects of a musical performance; (3) the teacher's ability to demonstrate musically-related performance behaviors (such as posture and embouchure); and (4) the teacher's ability to demonstrate short musical sequences by ear on an instrument. Sang noted the excessive amounts of time spent by music teachers in verbal communication (band directors: 42%; choir directors: 40%). The potentially more effective (and more time-efficient) method of modeling is suggested as a means to better musical performance and better classroom management. Sang stated that musical discriminations are not effectively taught through verbal description and that kinesthetic response cannot be improved through discussions of such musical concepts as tempo, meter, and subdivision. As practical solutions, Sang suggests better in-service and pre-service training for teachers on the aspects of modeling.

Zurcher (1975) studied the effectiveness of audio taped models on beginning brass students' performance achievement. Subjects (N = 43) were divided into two groups by random assignment. Treatment (taped model) was alternated with control (no tape) settings within each group. That is, if the first group had the tape model in week one,
then the second group would have the tape model in week two. There were six weekly observations for each subject via 15-minute lessons with the investigator. Practice time for each student was also monitored. Statistically significant results indicated that model-supportive practice was more effective than free practice in aiding overall improvement, specifically reduction of gross pitch errors, pitch matching, rhythm error reduction, and amount of time spent practicing. The Spearman rank coefficient showed no correlation between total practice time and performance achievement.

Rosenthal (1984), and Rosenthal, Wilson, Evans, and Greenwalt (1988) produced two studies involving graduate and upper-level undergraduate instrumentalists. In the 1988 study, subjects (N = 60) were divided into five groups. The first group listened to a recording (model) of the excerpt chosen for this study. The second group sang the composition during their practice session. The third group analyzed the music silently. The fourth group practiced freely, and the fifth group served as the control group, practicing an entirely different composition. Results demonstrated that the free practice group and the modeling group had significantly better scores in phrasing, tempos, and articulation. The silent analysis group showed
the most improvement in the area of rhythmic accuracy; however, this group did not score as well in other areas. Rosenthal concluded that listening to a model alone, without opportunity for practice, might be as effective as practicing with the instrument in hand.

These data supported previous findings by Rosenthal (1984). This study involved 44 graduate and upper-level undergraduate instrumentalists, divided into four groups. The first group listened to a guide instruct them while a model performed the experimental etude. The second group listened only to the model. The third group heard only the verbal guide. The fourth group practiced freely. Average time for the experiment was 15 minutes per subject. Significant differences were found among groups in performance of tempos, dynamics, notes, and rhythms. The use of a model was significantly more effective in fostering improvement than the use of a model in conjunction with spoken instructions, free practice, or spoken instructions alone.

While Rosenthal, Puopolo (1971), and Zurcher (1975) used audio taped models of performance, Linklater (1997) compared the effects of video taped models, audio taped models, and a non-modeling, audio tape treatment on the musical achievement of fifth-grade and sixth-
grade students (N = 146). Subjects in the video modeling group received a video tape of visual and aural clarinet models plus instrumental accompaniments. Subjects in the audio modeling group received an audio cassette tape with aural clarinet models plus instrumental accompaniments. Subjects in the non-modeling group received an audio cassette tape of instrumental accompaniments.

Results showed that there was a significantly higher score for the video tape group in visual/physical performance criteria (posture, embouchure, instrument position, and hand position) as compared to the non-modeling group. The advantage was not retained once students lost access to visual models. However, the video tape group scored significantly higher on tone quality/intonation performance criteria than the non-modeling group over three months later. Means of the audio modeling group were not significantly different than either of the other groups.

Dickey (1992) reviewed selected classroom modeling literature and found overall positive relationships between teacher modeling and student performance. Dickey’s review also indicated that modeling was an effective teaching technique for a wide range of ages and that both
live and taped models are an effective means of teaching students to make complex musical discriminations.

One dissenting note in this body of modeling literature comes from Hellman and Elliot (1999). Their investigation of seventh-grade, beginning band students ($N = 46$) revealed no significant differences among those who received audio (taped) models, audio (taped) models with verbal instruction, live models, live models with verbal instruction, verbal instruction alone, and no model or verbal instruction. The investigators noted that the sample size was rather small (statisticians suggested the need for 200 subjects or more for this study) and that very large differences in performance would have been needed to reach statistical significance.

**Tempo**

If literature dealing with practice techniques is scarce, then the literature dealing with tempo adjustment as it relates to music learning is even scarcer. Since this avenue of investigation deals primarily with fine motor learning, other fields may prove helpful in gaining perspective. Some of the more pertinent information comes from the fields of sports medicine and athletics.
A review of literature concerning proprioceptors\(^2\) led Hutton and Atwater (1992) to conclude that selective training, that is, training to a specific task, creates the optimal motor learning environment. An example of this comes from Dunham and Kell (1980). Here the investigators tested two steady-increase treatments with a constant, at-criterion-tempo treatment to determine learning efficiency on a rotary pursuit task. In a rotary pursuit task, the subject manipulates a hand-held pointer to track a small, circular, moving target located on the edge of a rotating turntable. The amount of time a subject keeps the hand-help pointer in contact with the moving target is the dependent variable in rotary pursuit tasks. Since the task involves smaller muscle groups, it is generally considered to be a good gauge of fine motor acuity.

Subjects (N = 60) were right-handed undergraduate physical activity students. They were divided into three groups. This procedure used a trials-to-criterion measure of comparison. That is, the number of trials needed to perform the task at the level previously specified was the empirical dependent measure. A subject's score was thus the

\(^2\) Any of the sensory end organs in the muscles, tendons, etc. that are sensitive to the stimuli originating in these tissues by the movement of
number of trials needed to meet the criterion. The criterion was set at 70 percent accuracy for achievement.

Group one practiced only at 40 revolutions per minute (the criterion tempo). Group two practiced at 10 rpm until criterion was reached and then progressed to 20, 30, and 40 rpm, moving to the next speed only after the criterion was met. Group three began at 5 rpm and increased by 5 rpm increments until the criterion was met at 40 rpm. Mean trials were 12.70 (Group One), 13.05 (Group Two), and 20.85 (Group Three). Statistically, Group One and Group Two differed from Group Three but not from each other. The investigators conclude that specific task practice may be superior to shaping (successive approximations) in motor skill acquisition.

Similar results were found by Leonard, Karnes, Oxendine, and Hesson (1970), who used a rotary pursuit task. Subjects were divided into five groups (n's = 15) and trained at 30, 40, 45, 50, and 60 rpm. Forty-eight hours later, all subjects were tested at 45 rpm. After five testing trials, results showed statistically significant lower scores among those trained in the extreme groups (30 and 60 rpm) as compared to those in the central groups. However, after the first
block of five trials, subsequent five-trial blocks did not differ in a statistically significant manner. After 45 trials, performance was similar. Interestingly, those who trained at 60 rpm showed lower scores (although not statistically significant) than subjects who practiced at 30 rpm in training. The investigators concluded that specificity of training is a benefit to fine motor performance.

A subsequent investigation (Dunham and Frens, 1983) used the same apparatus and the same criterion tempo and percentage of contact for success, this time using a smaller target to follow for some subjects as another dependent variable. This investigation was designed to test a focus on speed versus a focus on accuracy during training. Subjects were 40 right-handed males. Results indicated no significant differences between those subjects whose training emphasized speed and those subjects whose training emphasized accuracy.

Ammons, Ammons, and Morgan (1956) used a rotary pursuit task with 192 girls. Using speeds of 40, 50, 60, and 70 rpm, researchers used 16 combinations of training speeds and transfer speeds. Here, the dependent measure was the percentage of accuracy during the transfer speed. Results showed that the transfer of training
was directly proportional to the similarity between the rates of the training task and the experimental task. The investigators concede that the best training speeds were indeed slower than the final speed. Nevertheless, the results tend to show an advantage to training specifically toward the target speed.

Results of research in fine motor skills are, therefore, mixed. Further, Shaffer (1981, 1982) suggested that musical timing may be strikingly different than that needed for other fine motor skill areas. He noted that instead of rpm, musicians must deal with beat subdivisions, a different concept altogether.

Tempo has a definite effect on the motor system's response to stimuli. Repp (1997) further studied the effect of tempo on the pedal timing of pianists. Subjects (N = 10) were of varying abilities and accomplishments. Each subject performed two musical excerpts at three different tempos (60, 72, and 84 bpm). The music used in this study did not allow for great fluctuations in finger legato or expressive timing. Responses were recorded in MIDI format and analyzed using correlations and linear regression analysis. Results indicated that pedal timing showed no specific relationship to global tempo changes. Further, there seemed to be two different reactions to changes in
global tempo: one for the manual key depressions (fingers) and another for pedal timing (foot). The results of this study become increasingly important when considered in conjunction with the work of Heinlein (1930), which showed that pianists tend to exhibit a high degree of integration of manual actions and pedal actions.

Duke and Pierce (1991) approached tempo with a focus on transfer skills and their importance on the development of psychomotor skills. Thus, they designed a study in which context, tempo, and a basic knowledge transfer were considered. Subjects (N = 27) first learned nine "target measures" at a single tempo. These measures were then placed in three-measure phrases of varying contexts and tempos. Results showed that any tempo variation resulted in lower tempo accuracy, while faster tempos resulted in lower pitch accuracy. In terms of context, it was found that placing a high-difficulty measure directly before the target measure resulted in lower performance accuracy, while placing a simple, low-difficulty measure just before the target measure resulted in higher scores.

One of the more definitive tempo studies in the recent literature dealt with tempo gradations in piano literature. Donald (1997) collected data consisting of 160 separate learning episodes (40
subjects x four examples each). University keyboard principals and majors and were split into two groups, intermediate and advanced. Each group had its own set of practice passages, selected from standard piano literature. Each subject learned two ascending scale passages and two bi-directional scale passages using each of two tempo gradations.

The first tempo gradation was an incremental tempo increase. This group performed first at a slow tempo, next at an intermediate tempo, and finally at the prescribed tempo. In order to move to the next tempo gradation, the subject had to play the exercise repeatedly until they could perform two consecutive, errorless trials. Finally, the subject performed the passage at the prescribed tempo five times.

The second tempo gradation was an alternating tempo. Subjects played the passage at a slow tempo until two consecutive, errorless trials were performed. Next, the subject performed the passage at the prescribed tempo twice, regardless of any errors made. Next, the subject used the slow tempo until two errorless, consecutive trials occurred. This was followed by another two trials at the prescribed tempo. The slow tempo was introduced one more time, and the subject played the passage until the two errorless, consecutive trials
criterion was met. Finally, the subject performed the passage at the prescribed tempo five times.

Dependent measures were the number of trials needed to meet the pre-determined criterion and the number of errorless trials performed during the final five trials. Donald also examined evenness of rhythm and tone as well as velocity of keystroke as shown through a MIDI file. Independent variables as described above were skill level (intermediate or advanced), scale type (ascending or bi-directional), and practice condition (Incremental Tempo Increase or Alternating Tempo).

Results showed the Alternating Tempo practice condition required fewer trials to criterion than did the Incremental Tempo Increase practice condition.\(^3\) No significant differences were found between the two practice conditions for the mean number of errorless trials, evenness of rhythm and tone, or keystroke velocity. Donald concluded that few differences were found between those in the Alternating Tempo group and the Incremental Tempo Increase group. However, the one key difference was that the Alternating Tempo
procedure, which introduced the target tempo earlier in the sequence, was significantly more efficient than the Incremental Tempo Increase procedure. Donald called the lack of empirical research in this area serious and suggested that more work is clearly needed in the area of tempo adjustment as it relates to music learning.

**Scoring**

The means of scoring musical performance is a concern in experimental research. Since music is, by nature, a subjective form, then specific behaviors may be deemed appropriate, inappropriate or some gradation between the two, depending on the perspective of the evaluator. When determining scoring procedure for this study, previous research literature was consulted.

Ross (1985) used the Watkins-Farnum Performance Inventory as a means of scoring performance of subjects. In scoring this inventory, any mistake of any kind is reason to count the entire measure wrong. Thus, pitches, rhythms, and articulations are compacted into a score of one or zero for each measure. The etude meter was initially 12/8. For scoring purposes, each measure was broken into two, 6/8 measures.

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Donald notes that the intermittent trials used in the Alternating Tempo condition (that is, the two trials at tempo, irrespective of
(Ross, 1998). This procedure allowed for a larger potential score and, thus, a larger possible variance in (distribution of) scores. This was important, as the performance evaluation mechanism only counts entire measures and not individual notes. A small potential score could lead to a positive skew of the data.

The computer has brought a new era in data collection. Studies as early as 1973 (Wagner, Pinotek, and Teckhaus) began exploring the computer as a research tool for musicians. Recent studies (Donald, 1998) used MIDI capabilities to determine key velocities, inter-onset intervals. Others use the computer to determine keyboard pedal timing (Repp, 1997). Data is collected by computer and analyzed to determine differences in pianists' evenness of volume and rhythm. The advantage of such a system is that the collected data yield to no subjectivity. However, one key disadvantage to this system is that such collection tools are limited to keyboard situations.

Studies involving music (Donald, 1997) and non-music (Dunham and Kells, 1980) dependent measures have used a trials-to-criterion measure to assess effectiveness of treatments. That is, a criterion is set, and the subject must make as many attempts as necessary to

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errors) were not included in the number of trials used in data analysis.
reach the established criterion. Although this measure approximates
the quickest way to reach a certain outcome, it does not address the
criterion itself. That is, whether the criterion is valid as a measure of a
specific skill. What might be more universally useful is measuring the
amount of achievement gained from a given treatment.

Rosenthal (1984) and Rosenthal, Wilson, Evans, and Greenwalt
(1988) scored results on a note-by-note basis. Notes, rhythms and
articulations were scored independently with scores later combined for
a reliability rating. Tempo was determined by timing the pretest and
scoring any deviation (too long or too short) against the total number
of seconds required to accurately play the etude.

The experiment used in this dissertation is an outgrowth of the
preceding studies. The methods used in this dissertation are derived
from a combination of the above studies.

Summary

Though significant in its findings, previous modeling research has
focused on either an older population of subjects or on beginners.
Previous tempo research has not dealt with all aspects of tempo
gradation, specifically the role that specificity (at-tempo) training can
play in mastering music. Music is a dynamic (not static) medium; a
musician, even at the most basic levels, must be concerned with many different facets of a piece. If modeling is to be effective, and if tempo gradation is also to be effective, then which combination of these two concepts would prove most effective?

Rosenthal mentioned the need for further study on younger subjects and subjects with less performance experience, while the studies by Puopolo (1971) and Zurcher (1975) dealt with one of the most unique musical populations, beginning brass players. This leaves uninvestigated a large population of music students who are neither beginners nor advanced collegiate musicians. Further, the Rosenthal research is focused on longer etudes, which gives rise to the question of more specific mechanics and short-term endurance. Zdzinski (1991) noted that fine motor research showed that the effect of modeling differed by age. Brooks (1995) notes in a review of research that modeling effectiveness “may be inversely correlated to age and musical experience.” (p. 7)

These questions arise: How does modeling affect the rate of learning in a typical practice situation? Which tempo gradation would be most effective in promoting music learning? Is there some optimal combination of tempo gradation and modeling? Did the significant
improvements found in the aforementioned modeling and tempo
studies derive from the techniques used, or simply the fact that the
experimental conditions included more structure, generally speaking,
than other methods (Barry, 1990)? How do these two practice
techniques affect high school students?

More specifically, in the “real world,” when a student enters a
practice room and begins working on a piece of music, he/she will most
likely encounter portions of the music that are not initially playable. An
entire etude may consist of several of these sections which become
attainable with practice. In this situation, it might be that each section
is approached as a separate entity. What would be an effective
strategy for learning this smaller section? A model may prove quite
useful in this situation. However, according to Zdzinski (1991), the
correct placement of the model in the learning sequence is important
to the model’s effectiveness. Older students, according to Zdzinski,
would best utilize a model after initially learning the basic foundations
of the music at hand (that is, pitches, rhythms, and articulations).
However, high school musicians span a middle area between the
beginning musicians and advanced musicians which have already
benefited from modeling research. There must also be some
consideration given to initially mastering the pitches, rhythms, and articulations, which require simple fine motor acuity, before nuances may effectively be added. Whether a model can help high school students achieve this initial mastery will be a focus of this investigation.
METHOD AND DATA ANALYSIS

The purpose of this study was to examine the effect of modeling conditions and tempo gradations as practice techniques on the performance of high school instrumentalists. Specifically, the independent variables of this study were model versus no model and steady increase of tempo versus performance (target) tempo versus alternating (slower and faster) tempos. Dependent measures were pre-posttest gain score comparisons of percentages of correct pitches, rhythms, and articulations, as well as overall tempo gains.

**Subjects**

The target group for this experiment was high school-age musicians between the ages of 14 and 19. Subjects (N = 60) were enrolled in high schools in the American Midwest and South.

Only high school band members and wind ensemble members were used as subjects. No string musicians were used. Furthermore, the study was limited to woodwind and brass players, due to the non-melodic nature of most percussion instruments.

Due to the non-harmful nature of the experiment, oversight from the Human Subjects Committee at Louisiana State University and Agricultural and Mechanical College was deemed unnecessary.
Exemption from oversight was requested. The University's Human Subjects Committee granted this request. However, permission from parents was still sought. In addition, subjects agreed to participate in the experiment and were given the option of withdrawing from the experiment at any time. Permission was sought from each school used in this experiment (both the band director and the principal).

Selection of Etude and Experimental Design

One of the primary considerations of this experiment involved proper selection of an etude. The etude used in this experiment was chosen from a selection of 12 etudes that were designed for students of high school age. These 12 etudes were chosen from band method books, method books for individual instruments, and solo literature. Difficulty grade levels, which typically match the number of years of training required to adequately play a given etude, ranged from two to five. Each etude was pared to between 24 to 40 counts.

Directors were chosen from schools that represent a variety of geographic areas and demographic situations (urban and rural) on the basis of their willingness to allow experimentation involving their students. Directors each received a letter of explanation (see Appendix A) and a copy of all 12 excerpts. Directors were asked to
consider the following question for each excerpt: If your student musicians were to perform this excerpt individually, to what degree would the excerpt allow you to accurately rank order your students by performance ability? The directors then rank ordered the excerpts from most to least discriminating according to this criterion.

Any etude that was familiar to some or all of a director's students was eliminated from consideration. The etude with the lowest total ranking among these three band directors was chosen as the experimental etude. The lowest total ranking was determined by summing the rankings of each etude that received rankings from all three of the chosen directors (see Appendix B).

The etude with the lowest total ranking was “Norwegian Dance” by Edvard Grieg. The experimental etude came from Essential Technique, a band method technique book by Rhodes, Bierschenk, Lautzenheiser, Higgins, and Petersen (1993). The etude required the same melody for all instruments; octave and key transpositions were used to create the same concert key for all band instruments. The excerpt chosen for this investigation is shown in Figure 1.
This excerpt also matched criteria used in previous research (Barry, 1990):

The experimental etude used for all phases of this study must:
(a) be of an appropriate difficulty level for the subjects; (b) have moderate range; (c) contain a variety of rhythmic values; (d) be of relatively short duration; and (e) not be part of the standard band repertoire. (p. 6)

One cannot judge the difficulty of any given musical selection without considering the issue of tempo. The final tempo needed to pose enough of a challenge for the majority of subjects that the research questions would be answered. Selection of an inappropriate tempo (either too fast or too slow) would have increased the probability of a Type II (beta) error. That is, it would have increased the possibility of not finding significant differences when significant differences existed.

If the selected tempo had proven too fast, then the piece would have been too difficult for even the best musicians. Effects of
treatments would have then been masked by the fact that no subject (or very few subjects) would have been able to adequately perform the excerpt, despite treatment condition. Likewise, if all subjects had been able to play the piece, the effect of any given treatment condition would have been concealed by the general ability of all (or most) subjects to master the piece despite treatment condition. Thus, a target (performance) tempo of 84 beats per minute (bpm) was chosen, as it seemed to fit this criterion while avoiding the above issues.

The slowest tempo gradation selected for the Steady Increase (SI) group was 42 bpm, which is half the target tempo of 84 bpm. It was important in choosing this beginning tempo that the investigator err on the side of caution, if at all. To start subjects at a rapid tempo would have resulted in obscured results due to the imposed difficulty of just performing the excerpt. The slowest tempo allowed a starting point of departure so that every subject could play the piece with some degree of success. Furthermore, if the tempo had proven too slow for some, then the subjects in question would reach their initial comfortable tempo at some point during the treatment. Discussions with a leading music education tempo specialist (Duke, 1998; Duke,
1999) and further readings in fine motor skill research (Leonard et al, 1970) supported the idea of starting at half tempo.

This investigation included tempo gradations of 7 bpm for the SI group, which created an even increase in tempo over numerous trials. Tempos for each trial within groups are listed in Table 1. Although tempo increments of 7 bpm are uncommon in a typical practice atmosphere, the subjects' time became a consideration. Most metronomes are set at 3 or 4 bpm increments. However, at increments of 3 bpm, this experiment would take a total of 16 trials. At 4 bpm, this experiment would take a total of 13 trials. This was deemed too long, and a set of eight trials (pretest, six treatment trials, posttest) was deemed appropriate, as it required approximately 20 minutes to complete.

Table 1: Experimental Design

<table>
<thead>
<tr>
<th>No Model Presented</th>
<th>Steady Increase</th>
<th>Performance Speed</th>
<th>Alternating Tempo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Tempos: 84, 42, 49, 56, 63, 70, 77, 84)</td>
<td>(Tempos: 84, 84, 84, 84, 84, 84, 84, 84)</td>
<td>(Tempos: 84, 42, 84, 42, 84, 42, 84, 84)</td>
</tr>
<tr>
<td>Model Presented</td>
<td>Steady Increase with Model</td>
<td>Performance Speed with Model</td>
<td>Alternating Tempo with Model</td>
</tr>
<tr>
<td></td>
<td>(Tempos: 84, 42, 49, 56, 63, 70, 77, 84)</td>
<td>(Tempos: 84, 84, 84, 84, 84, 84, 84, 84)</td>
<td>(Tempos: 84, 42, 84, 42, 84, 42, 84, 84)</td>
</tr>
</tbody>
</table>

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To determine whether the proposed study was feasible, a group of 17 musicians was recruited to pilot the experiment. Subjects for this procedural pilot were freshman and sophomore participants in a college marching band. These subjects were not music majors. Subjects' major instruments were either clarinet or saxophone. In a follow-up questionnaire, each subject was asked to determine whether this exercise was appropriate for high school students. Of the 17 subjects, 16 agreed that this excerpt and this tempo structure would be appropriate for high school students, with the only dissenting subject suggesting the exercise was more appropriate for middle school. Difficulty ratings (with one being the easiest and ten being the most difficult) ranged from one to eight with a mean of 4.85. The mode and the median were both 5. Of the initial 17 subjects, one answered the question, "very easy," instead of assigning a number. Thus, the mean, mode, and median were calculated from the responses of 16 subjects. One factor that convoluted results was that subjects seemed to have difficulty operating the recording apparatus. For this reason, the investigator decided to remain present throughout each experimental condition.

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4 Of the initial 17 subjects, one answered the question, "very easy," instead of assigning a number. Thus, the mean, mode, and median were calculated from the responses of 16 subjects.
Selection of Model

Rosenthal (1984) and Rosenthal et al (1988) studied the effects of modeling on advanced wind instrumentalists. In these experiments, a violin was used as a model. Thus, no comparative modeling advantage would be offered to any one particular instrument. A similar situation was created for this experiment. A graduate-level violinist was used to record the model of the excerpt selection. This violinist, a string education graduate student at a large Southern university, had been concertmaster of a college orchestra as an undergraduate. The model recording was made on a Panasonic SV-3700 Professional Digital Audio Tape Deck using a Peavey microphone, Model PVM 480, to ensure the greatest clarity possible during transfer. Two faculty musicians listened to the model tape prior to the experiment to validate accuracy, musicianship, and appropriateness of the model. Spoken instructions were recorded digitally on high quality equipment, resulting in compact discs for each experimental group. The excerpt was modeled at all tempo gradations marked in the study below (that is: 42, 49, 56, 63, 70, 77, and 84 beats per minute). Each recorded tempo model was used where indicated in the Spoken Instructions, listed in the Procedure section.
**Procedure**

Subjects were assigned to one of the six experimental groups (Steady Increase, Performance Speed, Alternating Tempo, Steady Increase with Model, Performance Speed with Model, and Alternating Tempo with Model). Since the investigator had no previous knowledge of subjects' abilities, subjects were placed in groups on a sequential basis with some provision made for convenience of schedule. Students were generally placed in sequential order (In order that they arrived: Group One, Group Two, Group Three, Group Four, Group Five, Group Six, Group One, Group Two, Group Three, etc.). However, remaining tape on a cassette and remaining class time did play a role in determining which experimental condition to apply. For example, the shortest compact disc took just under 17 minutes of execution time. If there were only 17 minutes left of a class, or if there were only 17 minutes left on a cassette tape, then that shorter disc was used to facilitate scheduling and recording.

Each student received a questionnaire (see Appendix C) with a code number listed on the upper right hand corner. The subject then played the etude a total of eight times, using only one of the practice techniques. Each set of instructions was digitally audio taped,
transferred digitally to compact disc, and played for each student to ensure that each subject received the same set of instructions. The instructions were presented to the subject on a Magnavox Model 1113 compact disc player. Each subject was taped throughout the session using a Marantz Professional Portable Cassette Recorder, Model PMD 340 or a Fisher Model PH 463 Cassette Recorder.

All subjects entered a practice room, where an investigator was present to orient subjects and answer any questions. Students then sat in a provided chair with the required music in front of them on a music stand. The instruction compact disc relevant to their assigned group was then played for them. Subjects responded to the compact disc stimulus when instructed to do so. All other practice during the experimental condition was prohibited by the investigator. Complete recorded instructions are documented in Appendix D.

Dependent Measures

The dependent measure in this experiment was improvement, measured by a comparative percentage of correct responses. Judges analyzed performances for accuracy in the following four areas: pitches, rhythms, articulations, and tempo. Data for pitches, rhythms, and articulations was converted to percentages of correct responses.
(the number of correct responses divided by the number of total possible responses). Pitches and rhythms were judged "correct" or "incorrect." Specifically, this study focused on wrong notes, not out of tune notes, and wrong durations of notes. A rhythm mistake was operationalized as a deviation in rhythm greater than or equal to one sixteenth note in length. An articulation mistake was defined according to four criteria: (a) re-articulating when the excerpt called for slurring/tying; (b) slurring or tying when the excerpt called for some type of tongued articulation; (c) failing to observe staccato markings (d) failing to observe legato markings.

Analyses of variance were used to compare gain scores by treatments among each category judged: (1) pitches, (2) rhythms, (3) articulations, and (4) tempo.

Reliability

Each pretest and posttest was re-recorded onto an analog cassette tape. Thus, a final tape consisted of the subject’s experimental number followed by the subject’s performed pretest, followed immediately by the same subject’s experimental number (again) and the subject’s performed posttest. The experimental etude
was copied six times on an 8 1/2” x 14” sheet of paper for use in
scoring each subject’s performances. The investigator listened to each
performance (pretest or posttest) a minimum of three times,
concentrating, respectively, on pitch, rhythm, and articulation. If any
confusion ensued, the investigator would repeatedly listen to the
performance until satisfied with the scoring. An example of a
completed score sheet can be found in Appendix E.

A second, objective observer was used to scrutinize scorer
reliability. The reliability judge was a graduate student in music
education with a reputation for high musicianship. This judge was
recommended to the investigator by professors in the Music Education
Department of a large Southern university. The investigator and the
reliability judge discussed the criteria for correct and incorrect
responses. Data from one subject was randomly chosen and used for
practice reliability. After hearing the piece enough times to score all
six evaluation areas (see Appendix E), scores were compared. Low
reliability was found on the articulation portion of the rating. Criteria
were again discussed in direct relation to the task at hand. Upon a
second attempt, reliability was deemed acceptable by the investigator,
and the reliability judge was given the reliability tapes to evaluate.
In order to ensure that each treatment condition was equally represented, two sets of scores from each treatment group \((n = 12)\) from each practice technique were used in reliability calculation. A table of random numbers was used to determine which two of each group of ten recordings would be used for reliability-checking purposes. Reliability was determined by dividing the number of agreements by the number of agreements plus disagreements. The overall reliability score was .81. (.86 for pitches; .84 for rhythms; .73 for articulations)

Since some students had trouble following the metronome, the investigator chose to consider rhythm scores relationally. That is, scores were calculated on the basis of one note's relationship to other notes. Thus, if a student had chosen to perform the piece at half tempo, his/her rhythm score would not be affected by tempo. Although rhythm cannot completely be assessed without regard to tempo, the chosen scoring procedure seemed to best simulate the "real world" effect that the experiment was designed to simulate, while making note of as much improvement as possible.
RESULTS AND ANALYSIS

The purpose of this study was to examine the effect of modeling and tempo gradations as practice techniques on the performance of high school instrumentalists. Specifically, the independent variables of this study were model versus no model and steady increase of tempo versus performance (target) tempo versus alternating (slower and faster) tempos. Dependent measures were gain score percentages of correct pitches, rhythms, and articulations, as well as overall tempo gains.

An ANOVA was run on pretest scores to determine whether this potential threat to validity was significant. Results of this ANOVA showed no significant differences among groups for Pitch Pretest \[ E(5,54) = 1.80; p > .05 \], Rhythm Pretest \[ E(5,54) = .546; p > .05 \], Articulation Pretest \[ E(5,54) = 1.41; p > .05 \], or Tempo Pretest \[ E(5,54) = .821; p > .05 \]. Table 2 shows means for pretest scores and accompanying standard deviations by Group. Also, the dependent measures in this investigation were gain scores; thus, lower pretest scores did not necessarily affect overall gain. However, higher pretest scores...
scores could have created a ceiling effect, limiting potential gain of the better players.

Table 2. Pretest Means and Standard Deviations by Group

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</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>36.20</td>
<td>18.28</td>
<td>51.80</td>
<td>10.20</td>
<td>43.30</td>
<td>3.37</td>
<td>25.63</td>
<td>7.89</td>
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<tr>
<td>PS</td>
<td>46.70</td>
<td>17.75</td>
<td>53.10</td>
<td>9.46</td>
<td>44.10</td>
<td>6.57</td>
<td>26.60</td>
<td>8.72</td>
</tr>
<tr>
<td>AT</td>
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<td>20.66</td>
<td>47.30</td>
<td>11.41</td>
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<td>6.58</td>
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<td>13.834</td>
<td>53.40</td>
<td>4.766</td>
<td>43.50</td>
<td>5.82</td>
<td>33.25</td>
<td>8.28</td>
</tr>
<tr>
<td>ATM</td>
<td>28.30</td>
<td>17.78</td>
<td>50.30</td>
<td>8.11</td>
<td>42.70</td>
<td>7.76</td>
<td>28.32</td>
<td>8.47</td>
</tr>
</tbody>
</table>

As an example, consider subjects that score 60 on a pretest. Since the total score can reach no higher than 65, the greatest gain score possible for these subjects is five. If one group had significantly higher pretest scores than other groups, and if these scores precluded any large gains scores, then validity of collected data could be limited by initial subject ability.

Table 3 shows mean percentage gain scores and standard deviations for the With-Model condition by tempo gradations for rhythm, tempo, pitch, and articulation. Table 4 shows mean percentage gain scores and standard deviations for the No-Model condition by tempo gradations for rhythm, tempo, pitch, and
articulation. Mean percentage gain scores will be referred to throughout the ensuing analysis of results.

Table 3. Mean Percentage Gain Scores and Standard Deviations for With-Model Condition by Tempo Gradations

<table>
<thead>
<tr>
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<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SIM</td>
<td>9.10</td>
<td>11.81</td>
<td>15.80</td>
<td>21.31</td>
<td>9.10</td>
<td>12.66</td>
<td>52.48</td>
<td>71.24</td>
</tr>
<tr>
<td>PSM</td>
<td>17.90</td>
<td>11.77</td>
<td>9.60</td>
<td>5.32</td>
<td>7.70</td>
<td>7.06</td>
<td>61.90</td>
<td>38.51</td>
</tr>
<tr>
<td>ATM</td>
<td>23.30</td>
<td>34.08</td>
<td>16.50</td>
<td>10.74</td>
<td>7.60</td>
<td>9.56</td>
<td>33.90</td>
<td>42.33</td>
</tr>
</tbody>
</table>

Table 4. Mean Percentage Gain Scores and Standard Deviations for No-Model Condition by Tempo Gradations

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SI</td>
<td>11.60</td>
<td>15.95</td>
<td>10.30</td>
<td>11.06</td>
<td>7.30</td>
<td>7.23</td>
<td>24.30</td>
<td>22.73</td>
</tr>
<tr>
<td>PS</td>
<td>8.60</td>
<td>6.31</td>
<td>3.40</td>
<td>7.55</td>
<td>5.50</td>
<td>9.30</td>
<td>24.08</td>
<td>35.73</td>
</tr>
<tr>
<td>AT</td>
<td>10.00</td>
<td>11.34</td>
<td>3.90</td>
<td>22.86</td>
<td>7.10</td>
<td>12.12</td>
<td>14.40</td>
<td>17.16</td>
</tr>
</tbody>
</table>

Scores were subjected to analysis of variance for each dependent variable. Analysis of Pitch Percentage Gain scores revealed no significant differences between the With-Model and No-Model conditions nor among the three tempo gradations. Table 5 shows the ANOVA results for Pitch Percentage Gain scores by independent variables. The largest mean percentage gain was for the Alternating
Tempo with Model group ($M = 23.08\%$). The lowest percentage gain mean came from the Performance Speed group ($M = 8.60$; See Table 3 and Table 4).

Table 5. Analysis of Variance on Pitch Percentage Gain Scores

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling Condition</td>
<td>1</td>
<td>673.35</td>
<td>673.35</td>
<td>2.17</td>
<td>.15</td>
</tr>
<tr>
<td>Tempo Gradation</td>
<td>2</td>
<td>397.73</td>
<td>198.87</td>
<td>.64</td>
<td>.53</td>
</tr>
<tr>
<td>Modeling Condition *</td>
<td>2</td>
<td>674.80</td>
<td>337.40</td>
<td>1.09</td>
<td>.34</td>
</tr>
<tr>
<td>Tempo Gradation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>54</td>
<td>1 6760.70</td>
<td>310.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dependent Measure: Pitch Percentage Gain

The ANOVA in Table 6 displays a significant effect ($p < .05$) of Modeling Conditions on Rhythm Percentage Gain Scores. The With-Model condition ($M = 13.97\%$) was significantly superior to the No-Model condition ($M = 5.87\%$). Tempo Gradations had no significant impact on Rhythm Percentage Gain Scores. There were no significant interactions between Modeling Conditions and Tempo Gradations. The group with the highest mean percentage gain score was the Alternating Tempo with Model group ($M = 16.50\%$), which was followed closely by the Steady Increase with Model group ($M = 15.80\%$). The group with the lowest gain score was the Performance Speed group ($M = 3.40\%$; See Table 3 and Table 4).
Table 6. Analysis of Variance on Rhythm Percentage Gain Scores

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling Condition</td>
<td>1</td>
<td>997.28</td>
<td>997.28</td>
<td>4.61</td>
<td>.04</td>
</tr>
<tr>
<td>Tempo Gradation</td>
<td>2</td>
<td>450.26</td>
<td>225.13</td>
<td>1.04</td>
<td>.87</td>
</tr>
<tr>
<td>Modeling Condition *</td>
<td>2</td>
<td>150.77</td>
<td>75.39</td>
<td>.35</td>
<td>.71</td>
</tr>
<tr>
<td>* Tempo Gradation</td>
<td>54</td>
<td>11685.92</td>
<td>216.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dependent Measure: Rhythm Percentage Gain

Analysis of Articulation Percentage Gain scores also revealed no significant differences between the With-Model and No-Model conditions nor among the three Tempo Gradations. These ANOVA results are shown in Table 7. The Steady Increase with Model group had the largest mean percentage gain among groups (M = 9.10%). The smallest percentage gain came from the Performance Speed group (M = 5.50%; See Table 3 and Table 4).

Table 7. Analysis of Variance on Articulation Percentage Gain Scores

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling Condition</td>
<td>1</td>
<td>33.75</td>
<td>33.75</td>
<td>.35</td>
<td>.56</td>
</tr>
<tr>
<td>Tempo Gradation</td>
<td>2</td>
<td>25.63</td>
<td>12.82</td>
<td>.13</td>
<td>.88</td>
</tr>
<tr>
<td>Modeling Condition *</td>
<td>2</td>
<td>7.90</td>
<td>3.95</td>
<td>.04</td>
<td>.96</td>
</tr>
<tr>
<td>* Tempo Gradation</td>
<td>54</td>
<td>5282.90</td>
<td>97.83</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dependent Measure: Articulation Percentage Gain

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It became apparent during the execution of this investigation that some students \((n = 14)\) did not respond to the recorded metronome clicks in any appreciable fashion. Others stopped frequently during the pretest and/or the posttest \((n = 39)\). Still others mistook the metronome clicks to represent the eighth note instead of the quarter note. This made the tempo of performance (as measured in seconds) a confounding factor in the results.

For example, one subject may have focused primarily on matching the prescribed tempo. The pretest, while slow, hypothetically contained mostly correct pitches, rhythms, and articulations. The posttest, though up to speed, contained numerous mistakes not heard in the pretest. Thus, improvement of tempo took place at the expense of the other dependent variables.

On the other hand, one student may have chosen to completely ignore the metronome. Pitches, rhythms, and articulations became more stable over the course of the treatment, yet the tempo remained constantly below that posed by the recorded metronome. One student followed the rules to the point where sloppiness occurred. The other student, while meticulous, did not feel individually bound by the precepts that were supposed to be placed on all subjects. Tempo does
have a significant impact on results such as these. Therefore, the data analysis included tempo as a dependent variable to ensure that gains made in this area were considered.

The technique for determining tempo gain, used by Rosenthal (1984), and Rosenthal et al (1988), was timing the pretest, timing the posttest, and subtracting the posttest performance time from the pretest performance time. This result was then divided by the number of seconds elapsed in the model recording. The tempo gain was recorded as a percentage score, keeping it similar in nature to the three dependent variables.

Results from data analysis of Tempo Percentage Gain indicated a significant difference between Modeling Conditions ($p < .05$). These results are shown in Table 8. Again, the With-Model condition ($M = 49.43\%$) produced significantly higher gains than did the No-Model condition ($M = 20.93\%$). Again, Tempo Gradations had no significant effect on Tempo Percentage Gain. There were no significant interactions among Modeling Conditions and Tempo Gradations. The Performance Speed with Model group had the highest mean percentage tempo gain ($M = 61.90\%$). The lowest mean gain percentage was
found in the Alternating Tempo group (M = 14.40%; See Table 3 and Table 4).

Table 8. Analysis of Variance on Tempo Percentage Gain Scores

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F-Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling Condition</td>
<td>1</td>
<td>12095.65</td>
<td>12095.65</td>
<td>6.97</td>
<td>.01</td>
</tr>
<tr>
<td>Tempo Gradation</td>
<td>2</td>
<td>3870.11</td>
<td>1935.06</td>
<td>1.12</td>
<td>.34</td>
</tr>
<tr>
<td>Modeling Condition *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tempo Gradation</td>
<td>2</td>
<td>859.34</td>
<td>429.67</td>
<td>.25</td>
<td>.78</td>
</tr>
<tr>
<td>Residual</td>
<td>54</td>
<td>93689.66</td>
<td>1734.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dependent Measure: Tempo Percentage Gain

While observing subjects during the investigation, it became apparent that some students in the With-Model condition were fingering through the Experimental Etude while the recorded model was playing. Ross (1985) defines this as a type of mental practice. An unpaired t-test was run on all dependent variables. Results indicated that those subjects using this technique scored significantly higher than those who did not use this technique (t\(_{28}\) = 2.02; p < .05).
DISCUSSION

The purpose of this study was to examine the effect of modeling conditions and tempo gradations as practice techniques on the performance of high school instrumentalists. Specifically, the independent variables of this study were model versus no model and steady increase of tempo versus performance (target) tempo versus alternating (slower and faster) tempos. Subjects (N = 60) were high school wind instrumentalists from the Midwest and the South. Subjects sight-read an etude, practiced the same etude six times using one of six distinct practice conditions (combinations of the two independent variables), and performed a posttest on the same etude. Dependent measures were pre-posttest gain score comparisons of percentages of correct pitches, rhythms, and articulations, as well as overall percentage tempo gains.

Results demonstrated the With-Model condition to be superior to the No-Model condition in Rhythm Percentage Gain and Tempo Percentage Gain. There were no significant differences found among Modeling Conditions or Tempo Gradations in Pitch Percentage Gain or
Articulation Percentage Gain. Tempo Gradations had no significant effect on results.

Comparisons were based on performances of the Experimental Etude, which was chosen by participating band directors from an original list of 12 excerpts. Subjects were high school woodwind and brass instrumentalists from diverse backgrounds. All participants in this investigation were volunteers. Oversight exemption was granted from the Human Subjects Committee of Louisiana State University and Agricultural and Mechanical College. Permission for this investigation was sought from and granted by band directors and school administrators relevant to the subject pool. The investigation took place in band practice rooms. Subjects listened to digitally-recorded instructions, including a recorded metronome set to one of three different tempo conditions (Steady Increase, Performance Speed, and Alternating Tempo). In addition, half of the subjects listened to a recorded model of expert playing of the etude, while half did not. This created six separate practice techniques (Groups): Steady Increase, Performance Speed, Alternating Tempo, Steady Increase with Model, Performance Speed with Model, and Alternating Tempo with Model. Scoring was done in a manner consistent with the work of Rosenthal.
(1984, 1988), and consisted of the investigator counting each note as either right or wrong in three categories: pitch, rhythm, and articulation. Furthermore, Tempo Percentage Gain scores were calculated by timing the pretest, timing the posttest, subtracting the posttest performance time from the pretest performance time, and dividing this result by the number of seconds elapsed in the full tempo model recording.

The experimental conditions were designed to simulate a “real world” environment. The protocol required that the subject enter the testing room, initially perform (sight read) the etude, practice it as instructed for approximately 20 minutes, and play the music a final time to see how much improvement had taken place in this one session. The experiment sought to measure the amount of achievement realized in a single practice session, rather than the amount of practice required to play a piece perfectly (trials to criterion). The presence of the investigator throughout each session afforded the investigator the opportunity to observe and record data through casual observation during the experiment. This resulted in a better knowledge of where true differences might be found.
Results demonstrated a significant effect of Modeling Condition on Rhythm Percentage Gain scores and Tempo Percentage Gain scores. Tempo Gradations had no significant impact on any of the dependent variables, and there were no significant interactions between Modeling Conditions and Tempo Gradations on any of the dependent variables. Neither independent variable (nor their interaction) had any effect on Pitch Percentage Gain or Articulation Percentage Gain.

**Pitch Percentage Gain**

Although analysis of Pitch Percentage Gain scores revealed no significant differences between the With-Model and No-Model conditions or among the three Tempo Gradations, the largest mean percentage gain ($M = 23.08\%$) was for the Alternating Tempo with Model group. The lowest score came from the Performance Speed group ($M = 8.60\%$).

These results show only a trend toward a modeling effect, while previous research (Rosenthal, 1984; Rosenthal, 1988; Zurcher, 1975; Donald, 1997) found a significant modeling effect in this area. Differences in results may have to do with age differences among subject pools or means of scoring. Also, two significant outliers in the Alternating Tempo condition actually finished with a negative gain.
score. Apart from these two subjects, this effect is significant. Nevertheless, in a “real world” setting, all scores must be considered, as all music students must be considered.

Theoretically, alternating the tempo between the performance speed and a slower, more deliberate tempo gives the learner the opportunity to work out more difficult passages in a deliberate manner, while keeping perspective on the whole piece by interspersing this deliberate practice with rehearsals at the performance speed. This tempo alternation may be quite effective when learning pitches.

The Alternating Tempo with Model condition ($M = 23.08\%$) produced superior (although not significantly superior) Pitch Percentage Gain results as compared to the Alternating Tempo (No-Model) condition ($M = 10.00\%$). One reason for this result may be related to the key signature of the Experimental Etude. Since the etude was written in the key of $G$, a subject could play the etude using a typical wind band key of $B$-flat (two flats in concert pitch) and produce a minor-sounding performance. The model made most students aware of the more unusual and difficult key signature. Once the model had been presented, after the pretest, the investigator noticed that many pitches were corrected. That is, a student must
first know that something is being played incorrectly before knowing to make a correction. Modeling may be one effective way to ensure that students will be aware of these types of mistakes.

**Rhythm Percentage Gain**

Modeling Condition had a significant effect on Rhythm Percentage Gain scores. The overall mean percentage gain for the With-Model condition was 13.95%, which was significantly higher than that of the No-Model condition, 5.80%. Tempo Gradations did not demonstrate a significant effect by itself on Rhythm Percentage Gain, and there was no significant interaction between Tempo Gradations and Modeling Conditions.

Although the interaction between Tempo Gradations and Modeling Conditions did not prove statistically significant, the Alternating Tempo with Model group had the highest mean Rhythm Percentage Gain among groups ($M = 16.46\%$). This ranking is in line with data from the Pitch Percentage Gain analysis. The lowest gain score came from the Performance Speed group ($M = 3.40\%$). This is also in line with data from the Pitch Percentage Gain analysis.
Articulation Percentage Gain

Articulation Percentage Gain scores showed no statistically significant difference. However, the Steady Increase with Model group again showed the highest mean percentage gain of all Groups (M = 9.10%). The Performance Speed group again showed the lowest mean percentage gain (M = 5.50%).

One reason for this lack of significant differences in Articulation Percentage Gain may be that students had learned to focus on specific aspects of a given piece of music first. For example, one of the bands whose members participated in this experiment had a percussionist as its director. Some subjects from that band may have chosen to first focus on rhythms, next on pitches, and finally on articulations. Other students may instead have chosen to place initial focus on pitches. Those students who ignored audible metronomic clicks at times in a deliberate attempt to play each pitch perfectly exemplified this approach. The investigator did not notice any subjects with an initial focus on articulation.

Another reason for the smaller gain scores in Articulation Percentage Gain may be excerpt difficulty level. Many of the notes in the Experimental Etude were marked staccato. Simply playing the
notes tongued was therefore insufficient to merit a notation of "correct," according to the criteria outlined by the investigator in the Dependent Measures section. An etude with less detailed articulation markings may have led to an increased Articulation Percentage Gain difference among groups.

**Tempo Percentage Gain**

One important independent variable that was not considered in the initial experimental design was tempo. While observing subjects, it became apparent that their playing speeds did not always match the speed set by the metronome. Some students seemed to focus on tempo gain to the exclusion of all of the original dependent variables; thus, tempo gain was analyzed as a dependent variable.

Modeling Conditions had a statistically significant impact on Tempo Percentage Gain scores. The With-Model condition mean was 28.50% closer to the target tempo than the No-Model condition. As with Pitch Percentage Gain scores, Rhythm Percentage Gain scores, and Articulation Percentage Gain scores, Tempo Gradations had no significant effect on Tempo Percentage Gain scores. Also in line with previous analysis, Tempo Gradations showed no significant interaction effect with Modeling Conditions on Tempo Percentage Gain scores.
Unlike previous analyses, the group with the highest mean percentage gain score was the Performance Speed with Model group ($M = 61.89\%$). This may follow the research of Dunham & Kell (1980), which holds that specific task practice may be more effective than shaping. Like Dunham & Kell, this study involved speed, accuracy, and fine motor skills. Thus, this study may be seen as a musical extension of fine motor skill research from other investigators involved in different academic areas.

**Overall Implications**

The Alternating Tempo with Model group was superior to all other subject groups in Pitch Percentage Gain and Rhythm Percentage Gain, while the Steady Increase with Model group posted the highest Articulation Percentage Gain. Nevertheless, none of these results reached the level of statistical significance.

These results show a trend, which suggests that an alternating tempo may be the most helpful of the three tested Tempo Gradations for improving pitch accuracy and rhythm accuracy. This becomes especially true when the alternating tempo is aided by correct modeling (interaction). The fact that the Alternating Tempo with Model group was superior to all other groups in Pitch Percentage Gain leads one to
consider this the first choice among these treatments when pitch improvement is needed.

When considering rhythmic accuracy gains, the experiment indicates that use of a model, again, seems to be the best approach. In fact, the investigator noticed several instances of subjects saying things like, “I’m not playing that right,” during the testing condition. The rhythmic example provided by the model appears to act as a sort of teaching tool for those in the practice situation. The results of this experiment suggest that recorded models may well prove an effective way of guiding practice in the absence of an instructor.

Furthermore, models (both live and recorded) may serve as similarly useful aids in the rehearsal situation. Sang (1987) studied instructional practice using modeling versus talking. This investigator found that almost half (42% band; 40% vocal) of rehearsal time was spent on talking, while only about 3% of rehearsal was devoted to the potentially more effective tool of modeling. It stands to reason that modeling is more than an effective rehearsal method, it is also an effective individual learning tool.

Brooks (1995) cautions against using modeling as the sole music teaching technique, and this caution is well-advised. Although success
may be initially aided by live or recorded models, a learner may become dependent upon models. This can hinder the development of musical independence in a young musician. The Suzuki Method includes music reading in its curriculum because of this very independence. On the other hand, modeling may be one way of achieving musical independence. Teaching music students specifically how a written rhythmic pattern sounds may be akin to teaching foreign language by pairing a new word (spoken or written) with a picture of the object or action to which the new word refers. Although by no means the sole tool for musical learning, modeling can actually aid the music reading process.

Both the Steady Increase with Model group and the Alternating Tempo with Model group scored highly in Rhythm Percentage Gain. Both of these groups share a commonality in their tempo gradation: the presence of slower, learning tempos. These tempos give musicians the necessary time to “work out” difficult passages. Subjects using slower tempos more readily mastered some of the more difficult rhythms. The challenge then became one of transfer. That is, students then had to execute the newly-learned rhythmic pattern at a faster tempo. Both the Steady Increase with Model and the Alternating
Tempo with Model conditions proved more effective in Rhythm Percentage Gain; however, the added pitch gain found in the Alternating Tempo with Model group may be a reason to focus more readily on that Tempo Gradation as a practice scheme.

Practice at the Performance Speed, using a model, showed the greatest results among independent variables for percentage gains in tempo. It seems that tempo is best matched when practice is focused immediately on the target tempo. However, this particular condition does not necessarily lend itself to accuracy. The Performance Speed group produced the lowest means in Pitch Percentage Gain, Rhythm Percentage Gain, and Articulation Percentage Gain. Thus, the Performance Speed with Model condition may be best suited for assimilating proper tempo after the correct pitches, rhythms, and articulations have already been learned. This reasoning is in line with Zdzinski (1991), who noted that non-music research suggests that older students best utilize models to aid with the finishing stages of music learning after learning basic music concepts.

What may be most useful from these data is the beginning of a musician's ability to "prescribe" certain tempo gradations for use with specific needs. If future research holds with these results, one may
choose to treat a musical “problem” with practice at performance speed (to better match tempo) or practice with an alternating tempo (to correct gross pitch errors). This prescriptive, research-based approach may be what Barry (1990) sees as a primary goal of practice research.

The metronome may be one of the oldest of music teaching tools, and has proven useful for many musicians. However, a musician must first be trained to listen for the metronome “clicks” and adjust their playing to match the tempo set by the metronome. For some subjects in this experiment (n = 14), this training did not seem evident, as written investigator comments specifically mentioned subjects’ oblivious state concerning the recorded metronome. Since the tempo gradation treatment necessarily assumed a student’s ability to follow the metronome, lack of this ability in some subjects may have masked potential treatment effects.

Such previous metronome training may be necessary if research is to fully delineate the metronome’s most potent tempo gradations. A strong teaching implication arises here. If students are not taught to concentrate on the metronome, one may question whether they are taught to listen to anything outside of their own playing. This could have implications for balance, tempo cohesiveness, articulation
uniformity, intonation, dynamic contrast, rhythmic precision, and ensemble blend. Moreover, if students have not been specifically trained to work with a metronome, one may wonder whether these students have internalized the concept of steady beat. For all of the above reasons, it seems that a teaching approach that is focused on listening while playing would prove beneficial for overall ensemble playing as well as individual practice.

Other General Observations

Among the strengths of this investigation is the wealth of information it brings concerning the playing habits of high school students. The pretest recordings show typical behavior of high school students, while the posttest scores show the effect of modeling and tempo gradations on these same students. The recordings of the full treatment conditions offer insight as to how students may choose to focus effort and attention. A future study may look solely at pretest behaviors (possibly from this same data set) to determine typical approaches and problem behaviors of high school students.

One overall fact that was noticed was the variation of performance level of students within bands of various calibers. This experiment drew its subjects from bands that covered a wide range of
achievement levels. At the lower end was a band with a new director that was in the process of rebuilding. Its contest scores were typically low, as was general music knowledge. At the upper end of the spectrum was a band that is nationally renowned and often cited as an example of the possibilities of high school musicians. In both of these cases, as well as in all of the cases between the two, individual scores varied greatly. Some students were easily able to play near-perfect pretests. Other students in each band were unable to finish in the allotted time, and never fully performed the piece to the point of being recognizable. It seems that the job of the band director is to fashion each group of varied individuals into a fully cohesive unit. In other words, these bands did not seem to be differentiated by overall individual ability; rather, they varied in their accomplishments as a group.

In this investigation, the With-Model condition (offering limited guidance) was compared to, essentially, no direction whatsoever. Subjects could conceivably make the same mistakes eight times (pretest, six treatment executions, and posttest) without knowing that anything was wrong. If the investigator had told the student that the performance was too slow, that the key signature was being ignored,
or that articulation markings needed to be more closely adhered to, then the significant effect of modeling might have been lessened. Rosenthal (1984, 1988) studied modeling and its effect on advanced individual instrumentalists and concluded that listening to a model alone, without any verbal instruction, was more effective as a learning tool than listening to a model with an instructional voiceover. Nevertheless, at lesser levels of expertise, it would seem beneficial for some type of verbal instruction to be given to the less discerning subjects.

Limitations

Like most investigations, this dissertation is only a “snapshot” of music learning. There were design errors that may have masked results. Some subject reactions were quite unexpected, and thus were not accounted for in the design. In order for generalizations to be made from these data, it seems apparent that this study needs to be replicated and expanded. Some suggestions for doing so are mentioned below.

This study was limited by subjects’ frequent inability to concentrate on the recorded metronome or the insufficient technique to be able to follow it. This situation did not present itself in the
course of the pilot study. Thus, the investigator did not anticipate this issue in the experiment and had to react to a design flaw by adding a dependent variable (Tempo Percentage Gain) and scoring Rhythm Percentage Gains relationally. Another study of this kind might benefit to pretest subjects to determine their usefulness in a study that relies on a metronome as an integral part of treatment. Research may even lead to an effective way to teach proper use of the metronome.

While listening to subjects perform the Experimental Etude, it became evident that, at least initially, one particular group seemed to initially contain many of the better players. Fortunately, post hoc analysis showed no significant differences in pretest scores among groups. Nevertheless, the threat of a ceiling effect was considered. Since the investigator knew nothing about individual abilities, it was impossible to determine before the pretest how proficient a subject would be. Although the band director may have given more pertinent information as to subject abilities, this information was not requested. Thus, students were assigned to groups without regard for ability. Further research, or replication, may wish to consider grouping subjects such that ability levels are equivalent.
The presence of the investigator probably caused some subjects to be more nervous, focused, or distracted than they would have been in a typical, solitary practice situation. Although the investigator attempted to put subjects at ease, some difference in overall effect is unavoidable in such a situation. Initially, the design of the experiment called for the investigator not to be present in the practice room; however, serious complications arose in the pilot study when subjects were asked to push record buttons and stop buttons. Rather than lose data from subjects, this intrusion was considered necessary.

This investigation involved very limited periods of practice for each participant. There is a limit to how much one subject can learn in 20 minutes. This short time span also left the investigation vulnerable to outside influences, such as hunger, distraction, or initial nervousness. A study involving more time per subject and a longer etude might provide an interesting comparison to the data from this dissertation.

To further this line of reasoning, there may be another, more effective practice technique needed to perform a piece with perfection. Still another practice technique may be best for memorizing a piece of music. These issues lie beyond the scope of this dissertation, and
would need to be answered by research specifically focused on these aspects of learning music.

This study involved a subject pool of 60. A larger sample size might have offered more delineation among tempo gradations and between modeling conditions. Replication of this study on some level would go a long way toward solidifying these outcomes and conclusions.

The issue of tempo choice requires attention in the Limitations section. This may have been the first investigation that studied the effects of modeling on high school musicians. Tempo choice was difficult, as there was only one study that could be adequately referenced in this area. Donald (1997) used university keyboard players at an alternate tempo that was 7/11 of the full tempo. This investigation used high school wind instrumentalists with an alternate tempo that was half of the full tempo.

Was the Experimental Etude too difficult for these subjects? Was the target tempo of 84 bpm too fast? Results of posttests suggest that the answer to both questions is, “Probably not.” Mean percentage scores for posttests were 71.65% (pitches), 87.62% (rhythms), and 72.57% (articulations). Tempo posttest scores
averaged 23.62 seconds, only 6.28 seconds beyond the elapsed time in the full tempo model recording. These scores suggest adequate mastery of the Experimental Etude considering the time allotted for practice in this investigation.

On the other hand, the slowest tempo used in this study may have been a confounding factor. Here, this study stands somewhat in contrast to that of Donald (1997) who used a faster alternate tempo than the current investigation. Both studies found the alternating tempo to be a superior vehicle for achievement, but Donald’s study found the alternating tempo significantly superior while this investigation did not.

In the current study, the slower tempo in the Alternating Tempo gradation and the Steady Increase gradation was 42 bpm. This tempo may very well have been too slow. Donald (1997) used music that called for a performance tempo of 110 bpm. The alternate tempo in this study was 77 bpm. If the proportions are kept similar, then this investigation would have used an alternate tempo of about 53.5 bpm. When recording the model for this investigation, the violinist had much more trouble playing the Experimental Etude at 42 bpm and 49 bpm than at the full tempo of 84 bpm. Such a slow tempo may have done
more than change the character of the etude; it may very well have created additional difficulties for the subjects and hampered learning. The determination of the most advantageous alternations would be a valuable goal for future investigations. This investigation may offer future researchers an example of an alternate tempo that is too slow.

Other Suggestions for Further Research

Many different experts provide students and readers with non-research-based information on practicing. Among suggestions not tested in this investigation are repetition of a practice piece at a constant, slow tempo, use of a mouthpiece alone (for brass players), singing, mental practice techniques, and transformational practice techniques. Further research would do well to consider any of these practice tools in comparative tests of effectiveness.

Musicians consider good performance to include more than accurate pitches, rhythms, and articulations. Further research may wish to consider intonation, phrasing, dynamic contrast, and instrument timbre issues, among other possibilities. Although these musical characteristics are subjective in nature, this investigation used inter-judge reliability checking on partially-subjective quality judgements with some degree of success. Careful communication between judges may

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result in a means of evaluation for these subjective terms. Rosenthal (1984, 1988) used this same type of evaluation quite successfully.

Since this study involved only woodwind and brass players, one means of furthering this research would be to involve string players and percussionists (including pianists). Moreover, what would the comparative effect of modeling be among instrument families? Since a brass player is more prone to playing on a wrong partial, it would stand to reason that brass players as a group might benefit more from modeling than woodwind players. String players might find that their intonation would improve with proper modeling. This is a guiding principle behind the work of Suzuki (1969). Further research would be needed to answer these questions.

This study may have been the first study to investigate the effect of modeling on high school instrumentalists. The paucity of tempo gradation research was documented in the Review of Literature. Thus, another vein of research might be to use this combination of independent variables on an older population (college musicians or professionals) or a younger population (elementary or middle school musicians). These age groups present new abilities (such as ability to follow the metronome) and new performance issues. One interesting
idea would be a longitudinal study involving several different school music directors teaching different tempo gradation schemes as preferred practice techniques.

One exciting aspect of this research is its implications for the rehearsal setting. If a model is an effective teaching tool in an individual setting, it might prove just as useful in a group setting. If difficult passages are conducted in alternating tempos, learning may be better facilitated for many or all of the band or orchestra members. Further, a longitudinal study in this area could yield the most significant results to the music education community.

Although mental practice was mentioned in the Review of Literature, it was not an independent variable in this experiment. Nevertheless, observation of subjects during the experiments revealed their different approaches to learning the Experimental Etude, especially while the model was performing for them. Some subjects fingered through the music silently while the violin model was playing. Ross (1985) defines this behavior as one type of mental practice. Subjects who used this technique produced a mean rhythm gain score of 18.01% (p < .05), considerably higher than the mean Rhythm Percentage Gain score for those in the modeling group who did not
engage in mental practice (M = 7.69%), and reaching the level of statistical significance.

This statistic may be skewed in that those who practiced mentally might simply have been the most motivated learners. That is, they used this technique even when not instructed to do so. They may have even taught this technique to themselves. On the other hand, if students were given the instruction to mentally practice, it may have focused their efforts on the mental practice task, improving gain scores. Further research in this area might be warranted.

One practice technique not mentioned in the Review of Literature is music marking. Since the Experimental Etude used in this study was in the key of G-major, students could play the key using two flats (concert pitch) and produce a minor-sounding performance. It may be that placing sharps or natural signs in appropriate places on the music score would have improved overall performance. In this line of thinking, some verbal instruction may have been helpful to younger students. Although Rosenthal (1984) found any verbal instruction to be distracting to subjects, the study involved advanced, motivated learner-musicians. Some students in this study simply did not know that what they were playing was wrong. Some instruction from the
investigator may have proven helpful to subjects. Verbal instruction may yet be found to be a means of improving practice efficiency among younger players. Its potential for helping this group should be investigated.

The ideal focus of future research would be to develop a model of effective practicing using evidence and information garnered from research-based writing. As Barry (1991) hypothesized, there may be a way to prescribe a specific type of practice to solve a particular musical problem for a particular musician. This is truly a goal worth seeking. However, any such prescriptive formula should come from, or at least be tested by, the research community, and not single “practitioners,” if it is to be truly effective for the population known as musicians.
CONCLUSION

This dissertation has two primary strengths. First, it shows a strong effect of modeling on rhythm gain scores and tempo gain scores among high school students. Secondly, it offers an initial investigation into the practice techniques of high school students. Such studies were not found when reviewing the current literature; current studies on modeling are focused on both older and younger populations.

Problems occurred in this study that were not accounted for in the initial design. These problems included subjects who did not follow directions (pilot study), subjects who did not follow the metronome, subjects who occasionally or often stopped during the performance of the pretest and/or the posttest, a beginning/alternate tempo that may have been too slow, lack of control regarding subject group assignment, and extreme variations in results among subjects, and varying abilities of those assigned to various groups. Reactions to these problems included the presence of the investigator throughout the experimental condition and an added dependent variable (tempo).
In spite of this, it seems that to keep the "real world" nature of this study, all subjects had to be considered. It may have been prudent, in hindsight, to arrange a qualifying test to determine whether subjects had both the capability and the inclination to follow a metronome. However, this would have limited the subject pool to those with certain abilities. Such a condition may not adequately reflect the typical situation. The very title of this dissertation might have been changed to use the phrase, Advanced High School Instrumentalists instead of High School Instrumentalists. What is significant here is that students were chosen simply because they volunteered to participate. Any student could volunteer, and, thus, students of all ability levels participated. Even those subjects coming from the better bands in the study showed significant problems when determining proper pitch, rhythm, articulation, and tempo.

The music education research community as a whole needs to consider two basic aspects of music education: how teachers teach and how students learn. It is imperative that these two aspects be synchronized for optimal effectiveness. There are many fine examples of descriptive research detailing the activities of the current classroom.
Many of these studies follow their descriptions with analyses of what is and is not effective teaching.

This dissertation does not answer questions of teaching. Rather, it attempts to discern more clearly how students learn music, by practicing it, in this case. Specific to this investigation is the Experimental Etude, which serves as an example of other music placed in front of students throughout a school year. By first developing a better understanding of how students learn music, researchers can then begin the more significant process of developing, implementing, and evaluating better teaching methods.

Newman (1956) sums up the importance of more effective teaching by reminding us of the importance of learning music correctly the first time:

...the learning process does not distinguish between accidents and conscious efforts. Whatever is done is learned and becomes a muscular co-ordination. Mistakes become learned and stick just as correct procedures do. In fact, old mistakes, although they are subsequently corrected with great care, have a demonic way of turning up in public performance. (p. 105)

Whether a performance speed tempo gradation with a model is the best possible learning scenario for tempo in any piece of music remains to be seen. Whether the mean percentage gains shown by the
Alternating Tempo with Model group can generalize to significantly better learning of pitches, rhythms, and articulations is another question that can only be answered by much more research. However, if what has been garnered from the practice literature, including this dissertation, is then implemented in real-world settings with similar results, then we, as a research community, will have made a valuable contribution toward a more fulfilling experience for those music teachers and musicians who take heed of our knowledge.
REFERENCES


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APPENDIX A—LETTER TO BAND DIRECTORS

Paul Henley
3030 Congress Blvd. #10
Baton Rouge, LA 70808-3101
October 13, 1998

Mr. XXXXXXX XXXXXXX
XXXXXXXX XXXXXXX XXXX XXXXXX
XXX XXXX XXXXXXX
XXXXXXXX, XXXXX

Dear Mr. XXXXXXX:

Greetings from the bayou. According to our conversation, this letter acknowledges your agreement to aid in the design of my doctoral dissertation. The focal study of the dissertation involves the use of tempo gradations and models as practice techniques among high school musicians. As this research progresses, high school students will be used as subjects in an experiment. Each of these subjects will be given the same musical excerpt as part of the design instrument. Currently, your help and knowledge are being sought in the selection of this important excerpt.

Following this page, you should receive four more pages, the last three containing twelve music excerpts. Each excerpt should be numbered from one to twelve. Use the lines between each excerpt to delineate between the end of one excerpt and the beginning of the other. Please rank order the excerpts according to the criteria listed below. I do not need the copy of the excerpts returned, just your rankings. Any means of communication that is convenient to you may be used to send the results. Please consider using email or leaving your responses on my answering machine at home.

Some important issues need to be addressed by you and a few other select band directors. First the excerpt needs to be unfamiliar to nearly all of your students. If this is not so, then the excerpt should be marked with a zero (0).
Second, the excerpts are written for very different instruments. Some are written for tuba or trombone. These are marked with a bass clef and usually lie above or below the staff. Others are written for alto saxophone or violin and contain many sharps in their keys. Still others are written for trumpet or clarinet and fall well within ranges of most band and orchestra instruments. PLEASE DO NOT CONSIDER THIS WHEN JUDGING THESE PIECES. The final excerpt will need to be transposed for different instruments using different keys. Consider the appropriateness of the melody only. The most important aspect of the piece that is chosen must be its ability to discriminate.

Very few, if any, of your students should be able to play the piece at sight. Of course, there are always extremely exceptional individuals. Disregard these, but consider your better players on this point.

At the end of about ten minutes of practice, your better players should be able to play the excerpt relatively well (although not necessarily perfect). Your weaker players should still be having trouble with the etude on some level, but the etude should not be difficult to the point that the weaker players would gain nothing from a few minutes of practice on the excerpt. In a best-case scenario, the experiment itself will become a learning opportunity for each subject.

If you have any questions concerning this task, please do not hesitate to contact me using any of the means listed below. Your help in this matter, as always, is greatly appreciated. I am working on some fairly important issues here. When the study is complete, you will receive a copy, and my continued gratitude, for your efforts.

Sincerely,

Paul Henley
Graduate Fellow
Louisiana State University
phenley@unix1.sncc.lsu.edu
225/926-8694 (home)
225/388-3661 (school)
### APPENDIX B—DIRECTOR RANKINGS OF THE TWELVE EXCERPTS

<table>
<thead>
<tr>
<th>Director/Excerpt</th>
<th>Director 1</th>
<th>Director 2</th>
<th>Director 3</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excerpt 1</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Excerpt 2</td>
<td>N/A</td>
<td>11</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Excerpt 3</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>20</td>
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<tr>
<td>Excerpt 4</td>
<td>3</td>
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<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Excerpt 5</td>
<td>1</td>
<td>2</td>
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<td>N/A</td>
</tr>
<tr>
<td>Excerpt 6</td>
<td>4</td>
<td>9</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Excerpt 7</td>
<td>5</td>
<td>7</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Excerpt 8</td>
<td>6</td>
<td>1</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Excerpt 9</td>
<td>N/A</td>
<td>4</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Excerpt 10</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>Excerpt 11</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>Excerpt 12</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>14</td>
</tr>
</tbody>
</table>

Note: The term, Not Appropriate (N/A) indicates an excerpt that is unplayable by a significant number of students in this director’s band, or the term indicates that this director’s students are already familiar with this specific excerpt.
APPENDIX C—INFORMATION FORM

Subject:________________________

Name:___________________________________________________

Instrument:______________________________________________

Age (circle one): 14  15  16  17  18  19

Year in School (circle one): Fr. So. Jr. Sr.

Gender (circle one): M  F

Years of Training on This Instrument:________________________

Location (city, state):________________________________________
APPENDIX D—INSTRUCTIONS TO SUBJECTS

All subjects in the Steady Increase group entered the practice room, where an investigator was present to describe equipment usage and answer any questions. The investigator remained present throughout the experiment. Each experimental condition took approximately 20 minutes for each subject. Recorded instructions to the Steady Increase group were as follows:

You see before you an etude marked at 84 beats per minute. Please make sure that this etude is designed for the instrument that you are playing. You will play this etude eight times, recording the first time and the eighth time with the provided recorder. I will give you the tempo at which you will perform the etude. Please play along with the recorded metronome. Record the first time you play the etude by pressing the orange button on the tape recorder, speaking your secret code (found on the upper right hand corner of your registration sheet), waiting for me to say "One, two, ready, play," and then playing the etude to the best of your ability.

Please press the orange button now and speak your secret code number. You will have ten seconds to do this (Ten second tape delay here). Now, you will hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will likely continue for about ten seconds or so after you have finished playing. If you finish, and there is still a metronome playing, do not become discouraged or alarmed. This is all part of the design. Simply stop recording yourself by pressing the purple button on the recording device when you are finished playing. Now, here is your performance tempo (Metronome at 84 bpm; "One, two, ready, play," ) 27 seconds of metronome clicks. Please shut off the recording device if you have not already done so. Did you play

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the etude for the recording? If not, then please inform the experimenter. If so, then let's continue.

You will not record the next six trials.

You will next perform this piece at 42 beats per minute. You will now hear the tempo of 42 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 42 bpm. “One, two, ready, play.”*)

You will next perform this piece at 49 beats per minute. You will now hear the tempo of 49 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 49 bpm. “One, two, ready, play.”*)

You will next perform this piece at 56 beats per minute. You will now hear the tempo of 56 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 56 bpm. “One, two, ready, play.”*)

You will next perform this piece at 63 beats per minute. You will now hear the tempo of 63 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 63 bpm. “One, two, ready, play.”*)

You will next perform this piece at 70 beats per minute. You will now hear the tempo of 70 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 70 bpm. “One, two, ready, play.”*)
You will next perform this piece at 77 beats per minute. You will now hear the tempo of 77 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 77 bpm. “One, two, ready, play.”*)

You are now ready to make your final recording. Please press the orange button again now and speak your secret code number. You will be given ten seconds to do this. (*Ten second tape delay here.*) You will now hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will again continue for ten seconds or so beyond what is normally needed to play this etude. If you finish, and there is still a metronome playing, do not become alarmed or discouraged. This, again, is a part of the design. Simply stop recording yourself by pressing the purple button on the recorder when you are finished. Now, here is your performance tempo. Prepare to play on my cue one last time. (*Metronome at 84 bpm. “One, two, ready, play.”*).

Please shut off the recorder now by pressing the purple button if you have not done so already. Did you play for the recording? If not, please inform the experimenter. If so, then gather your belongings and exit the practice room, letting the experimenter know that you are finished. Thank you very, very much for your time and your cooperation.

All subjects in the Performance Speed group entered the practice room, where an investigator was present to describe equipment usage and answer any questions. The investigator remained present throughout the experiment. Each experimental condition took approximately 20 minutes for each subject. Recorded instructions to the Performance Speed group were as follows:
You see before you an etude marked at 84 beats per minute. Please make sure that this etude is designed for the instrument that you are playing. You will play this etude eight times, recording the first time and the eighth time with the provided recorder. I will give you the tempo at which you will perform the etude. Please play along with the recorded metronome. Record the first time you play the etude by pressing the orange button on the tape recorder, speaking your secret code (found on the upper right hand corner of your registration sheet), waiting for me to say “One, two, ready, play,” and then playing the etude to the best of your ability.

Please press the orange button now and speak your secret code number. You will have ten seconds to do this (*Ten second tape delay here*). Now, you will hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will likely continue for about ten seconds or so after you have finished playing. If you finish, and there is still a metronome playing, do not become discouraged or alarmed. This is all part of the design. Simply stop recording yourself by pressing the purple button on the recording device when you are finished playing. Now, here is you performance tempo (*Metronome at 84 bpm; “One, two, ready, play,”*) 27 seconds of metronome clicks. Please shut off the recording device if you have not already done so. Did you play the etude for the recording? If not, then please inform the experimenter. If so, then let's continue.

You will not record the next six trials.

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 84 bpm. “One, two, ready, play.”*)

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions. (Metronome at 84 bpm. “One, two, ready, play.”)

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 84 bpm. “One, two, ready, play.”)

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You are now ready to make your final recording.

Please press the orange button again now and speak your secret code number. You will be given ten seconds to do this. (Ten second tape delay here). You will now hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will again continue for ten seconds or so beyond what is normally needed to play this etude. If you finish, and there is still a metronome playing, do not become alarmed or discouraged. This, again, is a part of the
design. Simply stop recording yourself by pressing the purple button on the recorder when you are finished. Now, here is your performance tempo. Prepare to play on my cue one last time. (Metronome at 84 bpm. “One, two, ready, play.”). Please shut off the recorder now by pressing the purple button if you have not done so already. Did you play for the recording? If not, please inform the experimenter. If so, then gather your belongings and exit the practice room, letting the experimenter know that you are finished. Thank you very, very much for your time and your cooperation.

All subjects in the Alternating Tempo group entered the practice room, where an investigator was present to describe equipment usage and answer any questions. The investigator remained present throughout the experiment. Each experimental condition took approximately 20 minutes for each subject. Recorded instructions to the Alternating Tempo group were as follows:

You see before you an etude marked at 84 beats per minute. Please make sure that this etude is designed for the instrument that you are playing. You will play this etude eight times, recording the first time and the eighth time with the provided recorder. I will give you the tempo at which you will perform the etude. Please play along with the recorded metronome. Record the first time you play the etude by pressing the orange button on the tape recorder, speaking your secret code (found on the upper right hand corner of your registration sheet), waiting for me to say “One, two, ready, play,” and then playing the etude to the best of your ability.

Please press the orange button now and speak your secret code number. You will have ten seconds to do this (Ten second tape delay here). Now, you will hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will likely continue for about
ten seconds or so after you have finished playing. If you finish, and there is still a metronome playing, do not become discouraged or alarmed. This is all part of the design. Simply stop recording yourself by pressing the purple button on the recording device when you are finished playing. Now, here is you performance tempo (*Metronome at 84 bpm; “One, two, ready, play,”*) 27 seconds of metronome clicks. Please shut off the recording device if you have not already done so. Did you play the etude for the recording? If not, then please inform the experimenter. If so, then let’s continue.

You will not record the next six trials.

You will next perform this piece at 42 beats per minute. You will now hear the tempo of 42 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 42 bpm. “One, two, ready, play.”*)

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (*Metronome at 84 bpm. “One, two, ready, play.”*)

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You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 84 bpm. “One, two, ready, play.”)

You are now ready to make your final recording.

Please press the orange button again now and speak your secret code number. You will be given ten seconds to do this. (Ten second tape delay here). You will now hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will again continue for ten seconds or so beyond what is normally needed to play this etude. If you finish, and there is still a metronome playing, do not become alarmed or discouraged. This, again, is a part of the design. Simply stop recording yourself by pressing the purple button on the recorder when you are finished. Now, here is your performance tempo. Prepare to play on my cue one last time. (Metronome at 84 bpm. “One, two, ready, play.”). Please shut off the recorder now by pressing the purple button if you have not done so already. Did you play for the recording? If not, please inform the experimenter. If so, then gather your belongings and exit the practice room, letting the experimenter know that you are finished. Thank you very, very much for your time and your cooperation.

All subjects in the Steady Increase with Model group entered the practice room, where an investigator was present to describe equipment usage and answer any questions. The investigator remained
present throughout the experiment. Each experimental condition took approximately 20 minutes for each subject. Recorded instructions to the Steady Increase with Model group were as follows:

You see before you an etude marked at 84 beats per minute. Please make sure that this etude is designed for the instrument that you are playing. You will play this etude eight times, recording the first time and the eighth time with the provided recorder. I will give you the tempo at which you will perform the etude. Please play along with the recorded metronome. Record the first time you play the etude by pressing the orange button on the tape recorder, speaking your secret code (found on the upper right hand corner of your registration sheet), waiting for me to say "One, two, ready, play," and then playing the etude to the best of your ability.

Please press the orange button now and speak your secret code number. You will have ten seconds to do this (Ten second tape delay here). Now, you will hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will likely continue for about ten seconds or so after you have finished playing. If you finish, and there is still a metronome playing, do not become discouraged or alarmed. This is all part of the design. Simply stop recording yourself by pressing the purple button on the recording device when you are finished playing. Now, here is your performance tempo (Metronome at 84 bpm; "One, two, ready, play,") 27 seconds of metronome clicks. Please shut off the recording device if you have not already done so. Did you play the etude for the recording? If not, then please inform the experimenter. If so, then let's continue.

You will not record the next six trials.

You will now perform this same piece at 42 beats per minute. First, however, you will listen to a model of the etude performed at 42 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 42 bpm. "One, two, ready, play." Model performs.)
You will next perform this piece at 42 beats per minute. You will now hear the tempo of 42 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 42 bpm. “One, two, ready, play.”)

You will now perform this same piece at 49 beats per minute. First, however, you will listen to a model of the etude performed at 49 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 49 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 49 beats per minute. You will now hear the tempo of 49 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 49 bpm. “One, two, ready, play.”)

You will now perform this same piece at 56 beats per minute. First, however, you will listen to a model of the etude performed at 56 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 56 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 56 beats per minute. You will now hear the tempo of 56 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 56 bpm. “One, two, ready, play.”)

You will now perform this same piece at 63 beats per minute. First, however, you will listen to a model of the etude performed at 63 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 63 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 63 beats per minute. You will now hear the tempo of 63 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions.  (*Metronome
at 63 bpm. “One, two, ready, play.”*)

You will now perform this same piece at 70 beats per
minute. First, however, you will listen to a model of the etude
performed at 70 beats per minute. Please follow the music while
you listen to the model performing the excerpt.  (*Metronome at
70 bpm. “One, two, ready, play.” Model performs.*)

You will next perform this piece at 70 beats per minute.
You will now hear the tempo of 70 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions.  (*Metronome
at 70 bpm. “One, two, ready, play.”*)

You will now perform this same piece at 77 beats per
minute. First, however, you will listen to a model of the etude
performed at 77 beats per minute. Please follow the music while
you listen to the model performing the excerpt.  (*Metronome at
77 bpm. “One, two, ready, play.” Model performs.*)

You will next perform this piece at 77 beats per minute.
You will now hear the tempo of 77 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions.  (*Metronome
at 77 bpm. “One, two, ready, play.”*)

You are now ready to make your final recording.

Please press the orange button again now and speak your
secret code number. You will be given ten seconds to do this.
(*Ten second tape delay here.*) You will now hear the tempo you
will use for your recording. The metronome will play throughout
the recording. In fact, the metronome will again continue for ten
seconds or so beyond what is normally needed to play this
etude. If you finish, and there is still a metronome playing, do
not become alarmed or discouraged. This, again, is a part of the
design. Simply stop recording yourself by pressing the purple
button on the recorder when you are finished. Now, here is your

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performance tempo. Prepare to play on my cue one last time. (Metrone at 84 bpm. “One, two, ready, play.”). Please shut off the recorder now by pressing the purple button if you have not done so already. Did you play for the recording? If not, please inform the experimenter. If so, then gather your belongings and exit the practice room, letting the experimenter know that you are finished. Thank you very, very much for your time and your cooperation.

All subjects in the Performance Speed with Model group entered the practice room, where an investigator was present to describe equipment usage and answer any questions. The investigator remained present throughout the experiment. Each experimental condition took approximately 20 minutes for each subject. Recorded instructions to the Performance Speed with Model group were as follows:

You see before you an etude marked at 84 beats per minute. Please make sure that this etude is designed for the instrument that you are playing. You will play this etude eight times, recording the first time and the eighth time with the provided recorder. I will give you the tempo at which you will perform the etude. Please play along with the recorded metronome. Record the first time you play the etude by pressing the orange button on the tape recorder, speaking your secret code (found on the upper right hand corner of your registration sheet), waiting for me to say “One, two, ready, play,” and then playing the etude to the best of your ability.

Please press the orange button now and speak your secret code number. You will have ten seconds to do this (Ten second tape delay here). Now, you will hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will likely continue for about ten seconds or so after you have finished playing. If you finish, and there is still a metronome playing, do not become
discouraged or alarmed. This is all part of the design. Simply stop recording yourself by pressing the purple button on the recording device when you are finished playing. Now, here is your performance tempo (Metronome at 84 bpm; “One, two, ready, play,”) 27 seconds of metronome clicks. Please shut off the recording device if you have not already done so. Did you play the etude for the recording? If not, then please inform the experimenter. If so, then let’s continue.

You will not record the next six trials.

You will now perform this same piece at 84 beats per minute. First, however, you will listen to a model of the etude performed at 84 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 84 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 84 bpm. “One, two, ready, play.”)

You will now perform this same piece at 84 beats per minute. First, however, you will listen to a model of the etude performed at 84 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 84 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 84 bpm. “One, two, ready, play.”)

You will now perform this same piece at 84 beats per minute. First, however, you will listen to a model of the etude performed at 84 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 84 bpm. “One, two, ready, play.” Model performs.)
You will next perform this piece at 84 beats per minute.
You will now hear the tempo of 84 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions. (Metronome
at 84 bpm. “One, two, ready, play.”)

You will now perform this same piece at 84 beats per
minute. First, however, you will listen to a model of the etude
performed at 84 beats per minute. Please follow the music while
you listen to the model performing the excerpt. (Metronome at
84 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 84 beats per minute.
You will now hear the tempo of 84 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions. (Metronome
at 84 bpm. “One, two, ready, play.”)

You will next perform this piece at 84 beats per minute.
You will now hear the tempo of 84 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions. (Metronome
at 84 bpm. “One, two, ready, play.”)

You will next perform this piece at 84 beats per minute.
You will now hear the tempo of 84 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. *(Metronome at 84 bpm. “One, two, ready, play.”)*

You are now ready to make your final recording. Please press the orange button again now and speak your secret code number. You will be given ten seconds to do this. *(Ten second tape delay here).* You will now hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will again continue for ten seconds or so beyond what is normally needed to play this etude. If you finish, and there is still a metronome playing, do not become alarmed or discouraged. This, again, is part of the design. Simply stop recording yourself by pressing the purple button on the recorder when you are finished. Now, here is your performance tempo. Prepare to play on my cue one last time. *(Metronome at 84 bpm. “One, two, ready, play.”).* Please shut off the recorder now by pressing the purple button if you have not done so already. Did you play for the recording? If not, please inform the experimenter. If so, then gather your belongings and exit the practice room, letting the experimenter know that you are finished. Thank you very, very much for your time and your cooperation.

All subjects in the Alternating Tempo with Model group entered the practice room, where an investigator was present to describe equipment usage and answer any questions. The investigator remained present throughout the experiment. Each experimental condition took approximately 20 minutes for each subject. Recorded instructions to the Alternating Tempo with Model group were as follows:

You see before you an etude marked at 84 beats per minute. Please make sure that this etude is designed for the instrument that you are playing. You will play this etude eight
times, recording the first time and the eighth time with the
provided recorder. I will give you the tempo at which you will
perform the etude. Please play along with the recorded
metronome. Record the first time you play the etude by
pressing the orange button on the tape recorder, speaking your
secret code (found on the upper right hand corner of your
registration sheet), waiting for me to say “One, two, ready,
play,” and then playing the etude to the best of your ability.

Please press the orange button now and speak your
secret code number. You will have ten seconds to do this (Ten
second tape delay here). Now, you will hear the tempo you will
use for your recording. The metronome will play throughout the
recording. In fact, the metronome will likely continue for about
ten seconds or so after you have finished playing. If you finish,
and there is still a metronome playing, do not become
discouraged or alarmed. This is all part of the design. Simply
stop recording yourself by pressing the purple button on the
recording device when you are finished playing. Now, here is you
performance tempo (Metronome at 84 bpm; “One, two, ready,
play,”) 27 seconds of metronome clicks. Please shut off the
recording device if you have not already done so. Did you play
the etude for the recording? If not, then please inform the
experimenter. If so, then let’s continue.

You will not record the next six trials.

You will now perform this same piece at 42 beats per
minute. First, however, you will listen to a model of the etude
performed at 42 beats per minute. Please follow the music while
you listen to the model performing the excerpt. (Metronome at
42 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 42 beats per minute.
You will now hear the tempo of 42 beats per minute. Please wait
for my cue to begin playing. Again, the metronome will most
likely continue after you have finished. Do not be alarmed or
discouraged by this, as this is part of the experimental design.
Simply listen to the tape for your next instructions. (Metronome
at 42 bpm. “One, two, ready; play.”)

You will now perform this same piece at 84 beats per
minute. First, however, you will listen to a model of the etude
performed at 84 beats per minute. Please follow the music while
you listen to the model performing the excerpt. \textit{(Metronome at 84 bpm. “One, two, ready, play.” Model performs.)}

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. \textit{(Metronome at 84 bpm. “One, two, ready, play.”)}

You will now perform this same piece at 42 beats per minute. First, however, you will listen to a model of the etude performed at 42 beats per minute. Please follow the music while you listen to the model performing the excerpt. \textit{(Metronome at 42 bpm. “One, two, ready, play.” Model performs.)}

You will next perform this piece at 42 beats per minute. You will now hear the tempo of 42 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. \textit{(Metronome at 42 bpm. “One, two, ready, play.”)}

You will now perform this same piece at 84 beats per minute. First, however, you will listen to a model of the etude performed at 84 beats per minute. Please follow the music while you listen to the model performing the excerpt. \textit{(Metronome at 84 bpm. “One, two, ready, play.” Model performs.)}

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. \textit{(Metronome at 84 bpm. “One, two, ready, play.”)}

You will now perform this same piece at 42 beats per minute. First, however, you will listen to a model of the etude performed at 42 beats per minute. Please follow the music while you listen to the model performing the excerpt. \textit{(Metronome at 42 bpm. “One, two, ready, play.” Model performs.)}
You will next perform this piece at 42 beats per minute. You will now hear the tempo of 42 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 42 bpm. “One, two, ready, play.”)

You will now perform this same piece at 84 beats per minute. First, however, you will listen to a model of the etude performed at 84 beats per minute. Please follow the music while you listen to the model performing the excerpt. (Metronome at 84 bpm. “One, two, ready, play.” Model performs.)

You will next perform this piece at 84 beats per minute. You will now hear the tempo of 84 beats per minute. Please wait for my cue to begin playing. Again, the metronome will most likely continue after you have finished. Do not be alarmed or discouraged by this, as this is part of the experimental design. Simply listen to the tape for your next instructions. (Metronome at 84 bpm. “One, two, ready, play.”)

You are now ready to make your final recording. Please press the orange button again now and speak your secret code number. You will be given ten seconds to do this. (Ten second tape delay here). You will now hear the tempo you will use for your recording. The metronome will play throughout the recording. In fact, the metronome will again continue for ten seconds or so beyond what is normally needed to play this etude. If you finish, and there is still a metronome playing, do not become alarmed or discouraged. This, again, is a part of the design. Simply stop recording yourself by pressing the purple button on the recorder when you are finished. Now, here is your performance tempo. Prepare to play on my cue one last time. (Metronome at 84 bpm. “One, two, ready, play.”). Please shut off the recorder now by pressing the purple button if you have not done so already. Did you play for the recording? If not, please inform the experimenter. If so, then gather your belongings and exit the practice room, letting the experimenter know that you are finished. Thank you very, very much for your time and your cooperation.
The preceding page is an example of data collected by marking correct and incorrect pitches, rhythms and articulations from a subject’s pretest and posttest. The pretest markings consist of one music score for pitch, one music score for rhythm, and one music score for articulation. These three music scores are arranged in order (top to bottom) in the left column of the previous page. The corresponding music scores on the right side of the page are posttest scoring for the same subject. They retain the same order from top to bottom: pitch markings on top, rhythm markings in the middle, and articulation markings on the bottom.

Each slash through a note marks a mistake, as judged by the investigator. Each “OK” mark above a slash indicates where a note which is marked incorrect has been changed to correct on some subsequent hearing. Each slash through a space between notes in the rhythm section of the score sheet indicates a place where the subject stopped playing for any length of time. This stoppage was counted as one mistake.
Paul Thomas Henley was born in Aberdeen, South Dakota, on December 2, 1966. He is the son of Gerald D. Henley and Nadene A. Henley. He is married to DeAnn F. Henley and is the father of Victoria A. Henley. He has taught for seven years in public and parochial schools in South Dakota, Nebraska, and Iowa. He holds degrees from the University of South Dakota and Chadron State College, Nebraska. After completing his studies at Louisiana State University and Agricultural and Mechanical College, and earning the degree of Doctor of Philosophy, he plans to continue his academic career as Assistant Professor of Music Education at Western Montana College of the University of Montana in Dillon, Montana.
Candidate: Paul Thomas Henley

Major Field: Music

Title of Dissertation: The Effect of Modeling and Tempo Gradations as Practice Techniques on the Performance of High School Instrumentalists

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination: 6-25-99