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THE RELATIONSHIP BETWEEN SINGING INTONATION AND STRING PLAYING INTONATION IN BEGINNING VIOLIN AND VIOLA STUDENTS

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THE RELATIONSHIP BETWEEN SINGING INTONATION AND STRING PLAYING INTONATION IN BEGINNING VIOLIN AND VIOLA STUDENTS

By

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ABSTRACT

THE RELATIONSHIP BETWEEN SINGING INTONATION AND STRING PLAYING INTONATION IN BEGINNING VIOLIN AND VIOLA STUDENTS

By

Heather Elizabeth Frank

The purpose of this research was to develop an understanding of the relationship between singing intonation and string playing intonation in beginning instrumentalists. This study's specific problem was to investigate the relationship between singing intonation and playing intonation in fifth- and sixth-grade violin and viola players. Because their instruments have similar ranges, violinist and violists were incorporated into a single group.

Thirty-one beginning violin and viola players from one mid-Michigan elementary school were subjects in this study. These students were in their first or second year of public school string instruction. This investigation took place in two phases. During the first phase, each subject was asked to sing *Row, Row, Row Your Boat* alone and unaccompanied. Ratings from this phase determined that the rating scale was reliable. During the second phase, each subject performed *Yankee Doodle*, both vocally and instrumentally. The singing performances were evaluated by vocal judges, and the string playing performances by string judges.

The Pearson product-moment correlation coefficient found between the singing and string playing performance ratings was 0.41. This value was found to be statistically significant at the 0.05 level of significance. Thus, this study revealed a direct relationship between singing intonation and playing intonation.

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CHAPTER I
INTRODUCTION

On an early Monday morning, a teacher introduces the A major scale to a group of beginning string students. These students are familiar with the G and D major scales, and have learned about scale construction in general music classes. The students follow the fingering chart in a technique book and watch the teacher demonstrate the new A major finger pattern on the G-string. When the teacher asks the students to play the scale, mass chaos results. The teacher circles the room, making suggestions and moving fingers to more accurate locations. After this initial feedback, the students attempt the scale once again. The C-sharps are still not high enough, the G-sharps are nonexistent, and the fingered A's change with each bow stroke. The teacher is lost. After trying many strategies, she chooses to give up and move on to the next portion of the lesson. After class, she sits in her desk chair, pondering what went wrong that early morning. While she understands that young string players have a difficult time playing in tune, she was surprised at the extremity of the problem. "Why can't these kids play a simple scale in tune? Why can't they transfer what they know about other scales to this one? It would be wonderful to fix this problem and eliminate hours of remedial intonation work. How can I help them improve?"

This scenario is not uncommon in many beginning instrumental classrooms. Teachers often use several strategies to teach any given technique, but sometimes that technique may still not be achieved. How can these skills, such as accurate intonation, be improved? How can students learn to play more in tune?

Perceptions of String Intonation

Accurate intonation in an instrumental classroom is a common concern for many teachers. Perhaps string players have a difficult time playing in tune because their instruments require a unique type of facility to play. This physical technique is unique because, instead of relying upon frets and keys, the player must make minor adjustments with each fingertip on a smooth fingerboard. It has been written that string players must develop the "greatest sensitivity in hearing" (Stecklein & Aliferis, 1957, p. 14) because their instruments are "blind" (Stecklein & Aliferis, 1957, p. 14), lacking physical guidance built into their construction. Perhaps it is because of this that string players must rely on their hearing ability more than those in other instrument families. Stecklein & Aliferis (1957) found that college freshman string players with previous private instruction had the greatest ability to associate the music they heard to music written on the page, when compared to woodwind, brass, percussion, piano, and voice students. This concentration on listening may help these players pay closer attention to their intonation, thus improving their pitch accuracy.

While string players may be quite attentive to the sounds that they are producing, their interpretation of accurate intonation varies. These players demonstrate multiple concepts of what it truly means to play in tune. Studies that look at string intonation tendencies include those by Salzberg (1980), Kantorski (1986), Papich & Rainbow (1974), and Sogin (1989). Salzberg (1980) found that the pitch accuracy of university string players, all music majors, varied according to the type of musical exercise. In this study, the pitch accuracy within an ascending scale, arpeggio, double stops, and a short

melody was examined using Pythagorean intonation.[1] The pitch accuracy differed with each exercise; the melody line was played most accurately, while the arpeggio was performed with the least pitch accuracy. Also, string players had a tendency to play sharp when compared to Pythagorean intonation, which is generally more sharp than equal temperament.[2] This suggested that the intervals produced by string players conform more to Pythagorean intonation than equal temperament.

Kantorski (1986) looked at the difference in intonation accuracy of scalar passages in relation to different accompaniment intervals, and playing in different registers. He found that college string players, with an average of 10.2 years of playing experience, performed significantly sharper in higher positions with lower accompaniment than in lower positions with higher accompaniment, though both were sharp. Pitches accompanied at the intervals of a third or two octaves and a third produced a significantly greater deviation from equal temperament when compared to unison accompaniments. He also found that descending tetrachords were played significantly sharper than ascending ones.

Papich & Rainbow (1974) studied the characteristics of intonation and pitch vibrato of university string majors. They found string players' vibratos to be an upward "surge" in the initial attack of a tone, and when the tone was sustained, an oscillation in only an upward direction from the conceived pitch. In this study, violinists overestimated ascending intervals, playing sharp, and both cellists and violinists adjusted flat or sharp pitches with vibrato.

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[1] Pythagorean tuning is a scale tuning system with 12 unmodified fifths where enharmonic pitches differ in cents (Randel, 1999).

[2] Equal temperament is a scale tuning system based on 12 equal semitones within an octave (Randel, 1999).

Sogin (1989) looked at the performance pitch accuracy of college and professional string players within the duration of selected tones. He found that the pitch tended to rise toward the end of a duration, when part of either an ascending or descending pitch set. He also found that descending pitch sets were played significantly sharper than ascending sets, though both were played sharp, when compared to equal temperament.

Improving String Pitch Accuracy

Improving instrumental intonation has been a popular topic for many journal articles and studies. Because it is a primary concern for string teachers, many suggestions have been made for improving performance pitch accuracy. Experimental studies that investigate different strategies for improving string performance pitch accuracy include the use of a variety of treatments: instruction, feedback, harmonic accompaniment, finger-tape markers, and chamber music.

Studies looking at different instructional techniques include those by Cowden (1972) and Maag (1974). Cowden (1972) looked at the effects of first- and third-position instructional approaches on beginning violin intonation. Subjects in one group practiced melodies in first-position, while the other subjects practiced pieces in third-position. He found that there was no significant difference in the performance achievement between the groups. Maag (1974) compared the effects of a diatonic versus a pentatonic instructional method on beginning string students. He found that the comparison did not generate a statistically significant difference in intonation accuracy.

Salzberg (1980) examined the effect of feedback. She looked at the use of three different types of feedback (verbal, tape-recorder, and a model performance) on the intonation accuracy of four different musical exercises played by university string players. She found that the subjects that received verbal feedback played with the most accurate intonation and played significantly more in tune than those receiving tape-recorder or model performance feedback.

English (1985) and Bergonzi (1997) looked at the use of harmonic accompaniment. English (1985) looked at the effects of piano accompaniment on the intonation of a class of beginning string players. He found a statistically significant difference in the performance achievement of subjects receiving differing quantities of piano accompaniment. Subjects in an unaccompanied group were superior in performance pitch and rhythmic accuracy to those groups with varying amounts of piano accompaniment. Bergonzi (1997) looked at the effect of harmonic accompaniment and finger markers on developing intonation in individual string players, rather than a group of players. He found that subjects accompanied by harmony had a significantly higher degree of overall performance skill, incorporating the elements of tone quality, tempo consistency, rhythmic accuracy, and musical expression. No significant effect was found on intonation as a result of harmonic accompaniment in an individual setting, though subjects accompanied by harmony produced higher intonation scores than those not experiencing harmonic accompaniment. In addition, there was no interaction between harmonic accompaniment and finger placement markers. The controversy revolving around harmonic accompaniment suggests that more research is required in this area before conclusions may be drawn.

Many teachers choose to use finger-tapes, or finger placement markers, to help guide students to playing in tune. These slim pieces of tape serve as visual reference points for the fingers, helping players increase their confidence in correct finger placement. Smith (1985, 1987) and Bergonzi (1997) both focused on these markers. Smith (1985, 1987) looked at the use of fingerboard markers on beginning violin students' intonation. She found that the use of these markers did not produce significant gains in performance pitch accuracy. In addition, pitch accuracy declined when they were removed. Bergonzi (1997) examined the effect of using finger placement markers and harmonic accompaniment on the development of intonation in beginning string players. He found that subjects using the placement markers played significantly more in tune than subjects without the markers. However, he failed to test for pitch accuracy upon the removal of the finger placement markers. While the use of finger tapes is a common practice for many teachers, its long term effects on intonation is not yet clear.

Stabley (2000) and Carmody (1988) examined the effects of chamber music ensemble participation on the intonation and attitude of junior high age string players. Both studies found that the treatment groups experiencing chamber music improved their intonation and attitude, as compared to subjects not participating in chamber music. It is possible that the reason such gains were made was that students participated in a more intimate setting than the large orchestra rehearsals, and were provided with an immediate harmonic context. This type of setting forces students to listen more. The use of chamber music could be incorporated into many school programs in an attempt to increase pitch accuracy by providing a strong interactive listening environment.

Audiation and Vocalization in the Instrumental Classroom

Audiation, a term coined by Edwin Gordon (2003), refers to mentally hearing and comprehending music that was previously heard, or that was never physically present. Audiation takes place during activities such as composing, improvising, performing from notation, and listening to music. While the ability to audiate is directly related to music aptitude, students must be taught this skill. In the most basic level of discrimination learning, aural/oral, students must both listen to and imitate music. In a classroom, the teacher may vocalize a melodic or rhythmic pattern to be reproduced by the class. After a brief pause, to allow the students to comprehend and internalize the pattern, the students sing or chant the pattern back to the teacher.

One should learn to audiate at a basic level before playing an instrument. An instrument is viewed as an extension of the body. Therefore, if a student is unable to develop appropriate aural/oral pitch discrimination, instrumental performance will suffer. In order to attain instrumental performance pitch accuracy, a student needs to first be successful at tonal audiation, including aural pitch discrimination and oral singing performance (Gordon, 2003). It can be said that one must hear something before he or she can sing it, and sing it before he or she can play it. Because audiation is developed partially through singing, vocalization exercises may improve instrumental performance.

Studies that specifically pertain to the aural/oral transfer theory, without using vocalization exercises as classroom warm-ups, are those by Brick (1984), Eisele (1985), Smith & Brick (1990), and Smith (1995). Eisele (1985) looked at the effect of a computer-assisted pitch-matching program on the aural pitch discrimination and performance pitch accuracy of junior high age violin and viola students. While he found

that the subjects experiencing the treatment made significant gains in aural pitch discrimination, its effects on performance pitch accuracy were minimal. Brick (1984) designed an aural-oral pitch-matching training program to be used with the *Pitch Master*. He found that the treatment subjects, high school trombone players, made significant gains in performance pitch accuracy. Smith & Brick (1990), in a similar study, found that beginning violin students involved with the same pitch-matching program made significant gains in both aural pitch discrimination and performance pitch accuracy, though the magnitude of the gains were small. Smith (1995) also used the *Pitch Master*, but involved all four string instruments, and had the control group perform identical exercises. She also found that the training program could be used to develop both aural pitch discrimination and performance pitch accuracy.

Elliott (1974), Harris (1977), Davis (1981), Schlacks (1981), Beery (1996), Dell (2003), and Coveyduck (1998) investigated the use of singing in an instrumental classroom. Elliott (1974) looked at the effect of daily vocalization practice on the sense of pitch in beginning band students. He found that this practice had a significant effect on their sense of pitch discrimination. Harris (1977) studied the effect of an intonation training program, which included singing exercises, upon the intonation achievement, among other factors, of junior and senior high band students. He found that subjects in this program made significant gains in performance pitch accuracy. Davis (1981) looked at how structured singing activities and self-evaluation practice affected fifth- and sixth-grade band students' instrumental performance, as well as other factors. He found that subjects involved with singing activities during their first year of instruction had significant gains in instrumental performance, while subjects involved with self-

evaluation and a combination of singing and self-evaluation activities during their second year of instruction had significant gains in instrumental performance. In this study, instrumental performance consisted of several elements, one of which was intonation. Schlacks (1981) designed an interval training program to investigate the effect of vocalization on high school band students' pitch accuracy. He found that the group that both sang and played the intervals made the greatest gains in interval performance pitch accuracy skills. Beery (1996) compared an instructional technique incorporating the singing of rote songs and resting tones to traditional beginning band instruction. She found that the use of singing developed musical expression, but not intonation or phrase shaping. Dell (2003) looked at the effect of singing and tonal pattern instruction on the performance pitch accuracy of beginning string students. She used three methods: aural-based, aural-based with tonal patterns, and notation-based. She found that subjects participating in aural-based and aural-based with tonal pattern instruction performed with greater intonation accuracy than those with notation-based instruction. Coveyduck (1998) examined the effect of singing on the performance pitch accuracy of beginning band students. She found a significant difference between the instrumental intonation of subjects who sang and those that did not. However, when the data was further analyzed, she discovered that subjects taking voice lessons tainted the data, because they had more accurate intonation than those not taking voice lessons, in spite of belonging to either the experimental or control group. When these students were dropped from analysis, no difference was found. The results of these studies suggest that there is a connection between singing in tune and playing in tune.

Summary

Developing accurate intonation has been a topic of great concern for music educators. String players may have a greater problem with pitch accuracy than other instrumentalists because there is no physical marking built into their instruments to guide them to accurate intonation. A considerable amount of writing and research has focused on improving this area of performance. Because there is a wide variety of pitch perception among string players, several methods have been suggested to help combat this discrepancy. The literature shows that, among other techniques, vocalization in an instrumental classroom has a positive effect on performance accuracy. The use of a pitch-matching program has also been found, in some studies, to improve aural pitch discrimination and performance pitch accuracy. These findings suggest that students may be able to play in tune more accurately after being involved in treatments aimed at improving their pitch in singing. While these findings are important, they do not provide an understanding of the relationship between levels of singing pitch accuracy and playing pitch accuracy.

Purpose

With the intent of improving music instruction, the purpose of this research is to develop an understanding of the relationship between singing intonation and string playing intonation in beginning instrumentalists.

Problem

The primary problem of this study is to investigate the relationship between singing intonation and playing intonation in beginning violin and viola players. For the purposes of this study, violin and viola players were incorporated into a single group, because their instruments have similar ranges. Fifth- and sixth-grade string players took part in this study.

CHAPTER II
REVIEW OF RELATED LITERATURE

Introduction

Singing is an often-used teaching device in instrumental classrooms. Some music educators express the idea that, "if you can sing in tune, you can play in tune" (J.A. Palac, personal communication, November 15, 2005). Several studies show that vocalization practice develops one's sense of pitch (Elliott, 1974) and increases performance pitch accuracy (Dell, 2003; Harris, 1977; Schlacks, 1981). Studies involving pitch-matching programs demonstrate increases in performance pitch accuracy, sometimes accompanied by gains in aural pitch discrimination (Brick, 1984; Smith, 1995; Smith & Brick, 1990). These studies show a relationship between vocalization and instrumental performance after using some type of treatment. However, there is little research looking at the relationship between singing intonation and playing intonation, without treatment. This chapter further discusses and examines those studies involving singing in the instrumental classroom and pitch-matching programs, and their relationship to performance intonation.

Related Studies with Wind Instrumentalists

Elliott (1974) studied the effect of daily vocalization practice on sense of pitch. Elliott defined sense of pitch as the ability to: (a) detect slight pitch differences of consecutively sounded tones, (b) correctly recall a short melodic passage, (c) convert aurally perceived sounds into musical notation, and (d) convert musical notation into musical sounds.

The subjects of the experiment were 196 beginning band students from six public schools. There were three experimental groups and three control groups, each meeting for band for one period each day in heterogeneous classes. The experimental and control groups were similar in size, academic achievement, and extracurricular music activity participation. The pitch discrimination and tonal memory sections of the *Seashore Measures of Musical Talents* (1939 revision) were given as a pretest during week one of the school year to assess the subjects' ability to detect slight pitch differences of consecutively sounded tones and to correctly recall a short melodic passage. Based on these test results, the experimental and control groups were found to be similar.

The *First Division Band Method* (Parts I and II) was used with all classes. The experimental groups sang exercises from the text on "la." These exercises were modeled by the teacher during the first few weeks of the study. During Part I, subjects in the experimental groups played the exercises, sang, and played them once more. During Part II, the exercises were sung before they were played, with only the starting pitch sounded. The control groups were taught with each teacher's traditional method. During the last week of the school year, subjects were given the pitch discrimination (subtest A) and tonal memory (subtest B) sections of the *Seashore Measures of Musical Talent*; a test measuring the ability to match aurally perceived music with written notation (subtest C); the third test of the *Kwalwasser-Ruch Test of Musical Accomplishment* (1939), measuring the ability to convert musical notation into sound (subtest D); and a questionnaire to divide the experimental and control groups into subgroups for analysis. Subtest C and D were not given as pretests because it was possible that not all students were able to read music notation upon entering the beginning band class.

The results of this study reveal that the experimental groups scored significantly higher than the control group on subtests A, C, and D, as well as on overall scores. While the experimental groups' scores for subtest B were not significantly higher, they were still greater than those of the control group. Among several findings, Elliott found that vocal ensemble participation had little effect on test results. Subjects who participated in an extracurricular vocal ensemble scored similarly to other subjects, from the same experimental or control group, who did not participate in a vocal ensemble.

Because both the experimental and control groups made significant gains from the pretest to posttest on subtests A and B, Elliott concluded that regular participation in band resulted in improved pitch discrimination and tonal memory. In addition, regular vocalization in band had a significant effect on the experimental groups' sense of pitch; however, participation in a vocal ensemble made no difference.

While vocal ensemble experience was analyzed, only a small number of students were participants. This data must be interpreted with the understanding that only 36 of the 196 subjects participated in out-of-band vocal activities. Also, teacher instruction was not controlled, as six different teachers appear to have been participating in Elliott's study. The instructional methods used with the control groups are not indicated; therefore, it cannot be assumed that control subjects received similar instruction. It is also unclear if all beginning band subjects were of the same age. Clarification of teaching methods and subject age level would further strengthen the study's findings.

Elliott's study is different from the present study because he examined sense of pitch, not necessarily performance pitch accuracy. Though students both sang and played the same exercises in Elliott's study, their performances were not rated. The subjects'

sense of pitch was measured through aural testing, not through performance. The present study will measure sense of pitch as expressed through vocal and instrumental performance.

Harris (1977) examined the effect of an intonation training program on intonation achievement, as well as the relationship between intonation achievement and other personal factors. Harris wished to examine: (a) the relationship between the training program and student achievements in intonation, tonal memory, and auditory-visual discrimination; (b) the relationship between the training program and student attitudes; and (c) the relationship between intonation achievement and other factors, such as the number of years of piano study.

The subjects of this experiment were 54 eighth- through twelfth-grade students from the Champaign and Urbana, Illinois public schools. Instruction in this study lasted eight weeks during the second semester. The amount of instruction per week and per period was not revealed. After all students in the three participating wind ensembles took the pitch section of *Seashore Measures of Musical Talents* (1956), they were divided into three groups according to music aptitude (high, medium, low). Subjects from each aptitude level were then randomly divided to form two groups. A coin flip determined which group was experimental and which was control. Twenty-eight experimental and 26 control group subjects participated in this study.

Experimental groups received 30 minutes of instruction from the researcher, or a trained assistant, two times per week during regular band time. These small groups (n=6-8) consisted either of brass or woodwind players, not a combination of the two. The intonation training program focused on traditional instrumental techniques, studying each

instrument's intonational tendencies, and vocalization. Vocalization practice was not incorporated into instruction until the fourth or fifth training session, depending upon the school. The goal of incorporating singing into instruction was to help the subjects improve their instrumental intonation. Subjects, in groups, sang single pitches, scales, chord outlines, intervals, and simple melodies, produced by imitating other instrumentalists. In some exercises, the subjects would both sing and play the same exercise. Control groups attended regular band class, while the experimental subjects received intonation training. Band directors spent a majority of each control class period working on non-intonational skills such as rhythm and technique, as requested by the researcher.

Several tests were administered to the subjects, in addition to the pitch section of the *Seashore Measures of Musical Talents*. All subjects were individually given the *Individual Test of Intonational Skills II (ITIS II)* as a pretest and posttest. This test was developed by the researcher to measure intonation achievement on an instrumental exercise. During this test, each subject was asked to match, with his or her instrument, the pitch of a pre-recorded performance. *ITIS II* testing audio tapes were made with several common band instruments. Subjects needed to match single pitches, and play scalar and melodic exercises in unison with the recording. Each subject was given an opportunity to make mechanical adjustments to their instruments to increase their pitch matching accuracy. The *ITIS II* was evaluated by two judges. The auditory-visual discrimination subtest (Part 3: subtest a) from Colwell's *Music Achievement Test II* (1973) and the tonal memory section from Colwell's *Music Achievement Test III* (1973) were administered as a pretest and a posttest to examine tonal memory and auditory-

visual discrimination achievement. Each subject also completed a questionnaire before and after the treatment period. The information gathered, such as the number of years of piano study and student attitudes, was used to calculate a correlation between these factors, among others, and each subject's intonation achievement.

Non-significant pretest results on the *ITIS II* between the experimental and control groups, in addition to the random sampling of groups, suggested that the groups were approximately equivalent. However, the posttest results for the *ITIS II* did show a significant difference between the two groups, in favor of the experimental group, as well as significant pre/post gain scores for the treatment group. Analysis of subject responses on the questionnaire suggested that the intonation training program was generally received positively. In examining the effect of the program on tonal memory and auditory-visual discrimination, no significant differences were found between the two groups on either the pretest, posttest, or pre/post gain scores according to *Music Achievement Tests II* and *III*. Also, no significant correlations were found between intonation achievement (*ITIS II*) and musical aptitude (*Seashore*), or between intonation achievement and instrument timbre (low, middle, high). While a significant relationship existed between intonation achievement and private wind instrument study on the posttest scores for the treatment group, subjects in the control group did not show a significant relationship between intonation achievement and private wind instrument study. Harris suggests that while private instrument study is beneficial, it may not be enough to guide students to correct intonation unless paired with the training program.

Harris used a treatment, intonation training with vocalization exercises, to examine the intonation achievement of band students. Subjects in the treatment group

participated in both singing and playing exercises. In some instances, the subjects sang and played the same exercise. The results of this study suggest that participation in this type of program, with attention given to intonation, improved performance pitch accuracy. While singing was incorporated into the program, its accuracy in intonation was not measured, whereas instrumental performance was measured through the *ITIS II*. Also, a direct link between vocalization and instrumental performance cannot be determined in this study as vocalization was not the only form of treatment. In the present study, no treatment will be used to encourage and bring attention to playing in tune. Instead, the relationship between singing and playing intonation will be measured in an investigative approach.

Schlacks (1981) investigated the effects of an interval training program on the solo performance pitch accuracy skills of high school band students during the spring of 1979. In this program, designed by Schlacks, students sang intervals, played intervals, or practiced doing both. The major problems of this study were to: (a) determine if vocalization of intervals was a factor in improving pitch accuracy skills, (b) determine if instrumental playing of intervals was a factor in improving pitch accuracy skills, and (c) determine if both vocalization and instrumental playing of intervals were factors in improving pitch accuracy skills, as well as determine if this combination was a better technique than only vocalizing or playing alone.

The subjects of this experiment were 136 high school band students from four schools in the Fort Wayne, Indiana area. The study lasted for one month. Four high school bands from four high schools were randomly assigned to three treatment groups and one control group. Subjects in the experimental groups sang and/or played intervals

5-6 minutes daily, while subjects in the control group received normal instruction. The lesson plans for this study suggest that subjects regularly met for band on a daily basis, though the amount of instruction time is not specifically revealed.

During the study, the regular band instructors taught the subjects according to the group they were randomly assigned. Students at School A (n=31) both sang and instrumentally performed intervals; at School B (n=28) they only sang intervals; at School C (n=32) they only instrumentally performed intervals; and at School D (n=45), they maintained normal rehearsal. While the treatment groups varied in their performance of the intervals, several factors of the interval program were similar. Schlacks created a treatment tape to be used with Schools A, B, and C for 20 days, 5-6 minutes per day. The procedure used with this tape was as follows: (a) tune to B-flat pitch heard on the tape; (b) hear and see interval (interval type and concert pitch note names were stated, the interval was written on the chalkboard, and the interval was played), followed by the first note of interval sounded again; and (c) play or sing the interval. At this point, students at Schools A and B sang the interval, while those at School C played the interval. Then the instructors provided brief intonation feedback to the subjects; they could inform the subjects that they were inaccurate, but could not tell them if they had performed sharp or flat. Steps (a) and (b) were then repeated, but this time subjects performed by sections. Then the subjects performed as a group, with School A now playing the interval for the first time. The teacher provided feedback before the interval was played or sung for the final time (subjects at School A played by sections, while those at Schools B and C sang or played as a group). After five days of

becoming acquainted with this process, subjects in the treatment groups began to perform two intervals per day.

While all band students participated in the study, only woodwind and brass players were tested using a pretest/posttest design. The pitch recognition (test 3) subtest of Colwell's *Music Achievement Test (MAT)*, a written test, was given to measure gains in aural recognition of intervals. The *Interval Performance Test*, designed by the author, measured the subjects' ability to play both ascending and descending intervals, as compared to equal temperament. A portion of the *Watkins-Farnum Performance Scale* was given as a sight-reading exam; *Form A* was given as the pretest, and *Form B* as the posttest. Subjects took the pretests, completed a questionnaire pertaining to prior musical experiences (such as piano, music theory, choral experience, etc.), completed the treatment period, and took posttests. The researcher and one assistant analyzed the taped performances.

Analysis of these test results revealed no significant difference between the schools on the *MAT*. The results of the *Interval Performance Test,* indicated that while the vocalization or instrumental playing of intervals were factors in improving pitch accuracy, there was no statistically significant difference in interval performance improvement between either of these two treatment groups and the control school. However, the school that incorporated both vocalization and instrumental playing of intervals produced a significantly greater improvement in interval performance than the control school. While this school produced the greatest gains in interval performance, as well as aural recognition of intervals, neither of these gains was significant when

compared to the other treatment schools. In addition, choral music experience did not affect the results of the interval training program.

Schlacks used a treatment, an interval training program, to examine the solo performance pitch accuracy of high school wind and brass players. While each of the four schools was assigned a teaching method, four different teachers were involved with this study. Despite the daily intonation program's specific directions, there was no indication of the activities in which the subjects engaged during the remainder of their class time. In this study, not all students participated in singing exercises; therefore vocal intonation could not be measured. Only achievement in instrumental playing pitch accuracy was measured. Another concern with this study is its large attrition rate. The numbers of subjects at the beginning of the study for Schools A through D were 31, 28, 32, and 45, respectfully. When the mean and standard deviations for each school were revealed for each of the three tests, the total number of subjects for each school was different. In addition, the number of subjects involved within each school differed on each test. The number of reported subjects for the tests differed by as few as one subject, and by as many as 25 fewer subjects than at the beginning of the study. The results of this study may not be completely accurate due to the inconsistency in the number of subjects reported.

While this study fails to reveal a direct relationship between vocal and instrumental intonation, it does suggest that singing and playing the same exercises may improve performance pitch accuracy. In the present study, the relationship between vocalization and instrumental playing performance pitch accuracy of string players will be examined using identical musical material, without incorporating treatment.

A study looking at the development of pitch discrimination and pitch accuracy was conducted by Brick (1984). Brick designed the study to test Gordon's aural/oral transfer theory. The theory states that there is a transfer relationship between aural pitch perception and performance pitch accuracy. The major purpose of this research was to determine the effects of an aural/oral instructional program on the pitch discrimination and performance pitch accuracy of junior high trombone players.

The subjects of the experiment were 22 trombone players from two all-male junior high schools in Dade County, Florida. This study lasted for five weeks. The band director from each school paired the players according to overall performance ability, with one player from each pair randomly placed in the treatment group and the other in the control group. Because of an odd number of students at each school, unpaired trombone players were assigned to the treatment group. Thus, there were 12 subjects in the experimental group, and 10 in the control group. Subjects participated in daily instrumental performance classes. The nature of these classes is not explained. Subjects in the experimental group were excused from band rehearsal for two 30-minute sessions per week with the *Pitch Master*. Subjects in the control group continued with regular band rehearsal.

The TAP *Pitch Master* measures single pitches or melodic responses against prerecorded reference pitches or melodies. Three types of feedback are presented to the subject following each exercise: (a) auditory, (b) visual, and (c) number of correct responses. A correctly sung pitch is reinforced with the prerecorded pitch sounding through the headphones, a pitch meter measuring intonation against a medium line, and a numerical counter informing the subject of his or her achievement in matching pitches.

Through this feedback, the subject is encouraged to increase the score on the numerical counter, thus improving his achievement. Sixty-four musical exercises, divided equally among E-flat, B-flat, F, and C major, were used during this study.

All subjects were given the pitch discrimination sub-test of the *Seashore Measures of Musical Talents* (1939) *(SMMT)*, the *Measure of Isolated Pitch Accuracy (MIPA)*, and the *Measure of Melodic Pitch Accuracy (MMPA)* before and after the study. Both the *MIPA* and *MMPA* were designed by Brick for this study. *MIPA* measures the ability to perform a notated pitch with accurate intonation. *MMPA* measures general intonation accuracy in a performance. Brick chose pitches and composed exercises based on beginning band and beginning trombone literature.

Differences in pre-test scores between the two schools were not found to be significant; thus their data were combined for analysis. While *SMMT* revealed no significant difference, both *MIPA* and *MMPA* revealed significant differences in favor of the experimental group. Both of these tests reflected trombone performance, while the treatment only involved singing performance. Therefore, Brick concluded that the subjects in this study were able to transfer the treatment's aural/oral discrimination tasks to performance tasks.

In this study, Brick used a self-instructional program, incorporating three types of feedback, to help guide the subjects to accurate singing intonation. Trombone players served as subjects, part of an instrument family not directly related to the present study. However, these players also experience difficulty in physically attaining correct pitch due to variance in slide positions. Concerns about this study include the low number of subjects for each group, as well as the length of the study. Repeating this study with a

larger number of subjects for a longer time period might strengthen the results. While Brick looked at the relationship between singing accuracy and playing accuracy, vocal and instrumental performance accuracy were assessed differently. The present study will examine the relationship between singing and playing intonation, testing with identical material and not using any form of treatment or feedback.

Related Studies with String Instrumentalists

The development of pitch discrimination and pitch accuracy was examined by Smith & Brick (1990) during the 1988-1989 academic year. The purpose of this study was to examine the effect of an aural/oral pitch discrimination program, similar to that used by Brick (1984), on beginning violinists' aural pitch discrimination and performance pitch accuracy.

The subjects of the experiment were 28 fourth- and fifth-grade beginning violin students from a county magnet school. The study lasted for 16 weeks during the spring semester. Students from existing string classes were randomly assigned to either an experimental or control group. Subjects in the experimental group (n=14) were released from regular class instruction for two 30-minute weekly training sessions with the *Pitch Master*, and received individual training sessions on the machine before the study began. Subjects in the control group (n=14) had 50-minute class periods three times per week, and were also allowed to experiment with the *Pitch Master* with a different set of audio tapes. Both groups used Anderson and Frost's *All for Strings* method book (1985) during regular string class time. All subjects were given identical booklets containing the notation used for the pitch-matching exercises.

The *Pitch Master*, similar to that used in Brick's (1984) study, measures melodic responses against prerecorded reference pitches. Immediate feedback encourages the subject to increase the score on the numerical counter, thus improving vocal achievement. Sixty-four musical exercises, divided equally among D, G, F, and C major, were used during this study.

During the study, each subject listened to a pitch-matching exercise. The same exercise was repeated following a 10-second pause. The subject then sang the exercise into the *Pitch Master*. If a correct pitch was sung, it was reinforced by being produced by the machine. If the subject reached the required score on the numerical counter, the tape was turned off and the student played the exercise on his or her violin. If the subject failed to reach the required score on the numerical counter, the tape was rewound and the exercise begun again. Once the required score was reached and the exercise was played on his or her violin, the subject listened to the exercise for a final time before proceeding to the next pitch-matching exercise.

All subjects were given the pitch subtest of Colwell's *Music Achievement Test* (1967) as both a pretest and posttest to measure gains in aural pitch discrimination. Each subject also tape-recorded a 16 measure melody in D major at the beginning and end of the study. Three public school string teachers rated the performance pitch accuracy of these melodies with a continuous rating scale. Scores on the pitch subtest of the *Seashore Measures of Musical Talent* were used to adjust for initial differences in music aptitude between the experimental and control group.

The results of this study reveal a significant difference in aural pitch discrimination and performance pitch accuracy in favor of the experimental group.

While the aural/oral program brought significant gains, the actual gains in performance pitch accuracy were small in magnitude. The researchers suggest this may have been caused by the small sample size, among other variables. Smith & Brick's study differed from Brick's (1984) study because in the former, both singing and playing performances used the *Pitch Master*. Brick only used singing exercises with the *Pitch Master*.

Smith & Brick's study is similar to that of Brick (1984), as they both used a self-instructional program to help guide the subjects to accurate singing intonation. In Smith & Brick's study, the use of the program produced significant gains in both aural discrimination and performance pitch accuracy. However, this study does not reveal how the intonation of the singing exercise and playing exercise used with the *Pitch Master* relate to one another. The exercises sung and played into the machine were the treatment, not a measurement of achievement. Though the training program guided the subjects to accurate vocal intonation, this study does not reveal how this treatment affected an instrumental performance of the identical exercise. In the present study, identical exercises will be assessed to find a relationship between singing and string playing performance pitch accuracy.

A second string study looking at the relationship between aural pitch discrimination and performance pitch accuracy was conducted by Smith (1995) during the 1990-1991 academic year. The major purposes of Smith's study were to: (a) study the effects of an aural-oral pitch-training program on the aural pitch discrimination of beginning string students, and (b) analyze what effect gains in aural pitch discrimination had on performance pitch accuracy. This study is similar to Smith & Brick's (1990) study because it uses the *Pitch Master*, but is different because: (a) it involves all four

string instruments (violin, viola, cello, bass), and (b) the exercises sung and played by the experimental group with the *Pitch Master* were also played by the control subjects during class.

The subjects of this experiment were 80 sixth-grade string students from two public schools in the Seattle, Washington area. The study lasted for 16 weeks during the fall semester. All classes met daily for 50 minutes. Students from existing string classes were randomly assigned to either an experimental or control group, with two control and two experimental groups existing at each school. Subjects in the four intact experimental groups (n=42) were released from string class for two 20-minute weekly training sessions with the *Pitch Master*, and received individual training sessions on the *Pitch Master* before the study began. Subjects in the four intact control groups (n=38) performed identical exercises for 20 minutes in class without singing them. All subjects were given identical booklets containing the notation for the pitch-matching exercises.

The *Pitch Master* measures pitches, as in Brick's (1984) and Smith & Brick's (1990) studies. The procedure used with the *Pitch Master* was similar to that used in Smith & Brick's (1990) study, with a few alterations. Students received immediate feedback through a medium line and pitch lever, numerical counter indicating the number of pitches matched correctly, and the reference pitch heard through the headphones. In addition, if the exercise was sung correctly, the subject also heard his or her own voice through the headphones. This study required each subject to earn 90% of the possible points given on the numerical counter in order to advance to the next exercise. Forty-five musical exercises, divided equally among C, G, and D major, were used during this study. These exercises consisted of tonic, subdominant, and dominant tonal patterns.

The pitch subtest of Colwell's *Music Achievement Test* (1967) was used to measure gains in aural pitch discrimination. Each subject also tape-recorded three instrumental exercises, one each in C, G, and D major, before and after the treatment period. These exercises were similar to those used for the training program because they utilized tonic, subdominant, and dominant tonal patterns. A panel of three public school string teachers used a continuous rating scale to evaluate the taped exercises, concentrating only on the subject's performance pitch accuracy.

The results of this study suggest that the experimental groups that worked with the *Pitch Master* made statistically significant gains in both aural pitch discrimination and performance pitch accuracy. Smith concluded that aural/oral pitch matching training developed gains in aural pitch discrimination that were paired by gains in performance pitch accuracy.

Smith's study is similar to those of Brick (1984) and Smith & Brick (1990), as each study used a self-instructional training program to help guide the subjects to accurate singing intonation. In Smith's study, the use of the program produced significant gains in both aural discrimination and performance pitch accuracy. However, as with the study by Smith & Brick (1990), this study does not reveal how the singing exercise and playing exercise used with the *Pitch Master* relate to one another. The exercises sung and played into the machine were the treatment, not the measurement of achievement. Although Smith's training program guided the subjects to accurate vocal intonation, her study does not reveal how this treatment affected an instrumental performance of the identical exercise. In the present study, identical exercises will be

assessed to examine the relationship between singing and string playing performance pitch accuracy.

Dell (2003) studied the effect of singing and tonal pattern instruction on the performance pitch accuracy of beginning string students. Two research questions guided this study: (a) Would there be a difference in the intonation performance posttest scores for the groups instructed with aural-based, aural-based with tonal pattern enhancement, and notation-based methods; and (b) how might these scores differ as a function of treatment, pitch discrimination, and prior experience, while controlling for music aptitude?

The subjects of the experiment were 158 fifth- and sixth-grade beginning string students from nine intact classes in seven schools from two school districts in Columbia, South Carolina. Subjects received three or five days of instruction per week, depending upon the school. This study lasted from mid-August to mid-June of the students' academic year. Subjects in intact classes were assigned to one of the three treatment methodologies: (a) Aural-based instruction (n=59), (b) Aural-based with tonal pattern enhancement instruction (n=53), and (c) Notation-based instruction (n=46). All groups learned left- and right-hand technique to play their respective instruments and perform simple folk songs.

In aural-based instruction, rote songs and chants were used to aurally present new ideas. Subjects sang melodic and bass lines of new songs, incorporated harmony in review songs, practiced left-hand finger placement with solfege names instead of pitch names to strengthen interval understanding, drilled finger patterns by singing and playing melodic patterns, and improved right-hand technique by practicing musical examples in

various styles (such as connected or separated). Subjects practiced with the *Jump Right In String Series* CD (excluding tonal pattern tracks) prior to learning notation, and the *Essential Elements for Strings: A Comprehensive String Method for Strings* after notation was introduced in the fifth month of instruction. *Jump Right In* continued to be used to teach technique. Subjects learned to read songs that were previously taught by rote. Subjects were also asked to sing a line with solfege and chant its letter names before playing it pizzicato or arco. Approximately 10 minutes from each class period were designated for music-reading activities.

Aural-based, pattern-enhanced instruction incorporated the same activities as the aural-based instruction groups, as well as additional activities. Ten minutes of each class period were dedicated to introducing new concepts, such as tonal patterns, through vocalization and performance. Subjects sang and then played 16 two- and three-note major and minor, tonic and dominant patterns individually and as a class. Subjects practiced with the *Jump Right In String Series* CD (including all tracks) prior to learning notation, and the *Essential Elements for Strings: A Comprehensive String Method for Strings* after notation was introduced in the fifth month of instruction. After subjects learned to read familiar patterns, notation from *Essential Elements* was introduced. The subjects sang each exercise with solfege and chanted its pitch names before playing the exercise on their instruments. Approximately 10 minutes from each class period were designated for music-reading activities. *Jump Right In* continued to be used to teach technique.

Notation-based instruction introduced all concepts first through notation, then through discussion and performance. These control groups were introduced to new

material through the notation in *Essential Elements for Strings*. Left-hand finger patterns were learned through note names and their notation, while finger placement was learned through finger charts and diagrams. Exercises from this method book were used to drill finger patterns, and explanations of bowing styles were used to teach right-hand bowing technique. Minimal singing and harmonization were utilized with these groups.

An instrumental experience survey completed at the beginning of the treatment period served to account for the subjects' prior musical experiences. In order to examine and equate differences in music aptitude between the schools and districts, subjects took the tonal section of the *Intermediate Measure of Music Audiation (IMMA)* during the second month of treatment. During the early spring, the *Pitch Discrimination Measure* (*PDM*), developed by Dell, was given to measure each subject's pitch discrimination skills. In this test, subjects listened to the first phrase of an American folk song, followed by silence. The last few seconds of the same phrase were repeated, with the final pitch the same or mistuned a maximum of .25 cents either sharp or flat. Subjects determined if the repeated section was the same or not the same as the original sounding of the complete phrase.

The *Pitch Matching Measure* (*PMM*), also developed by Dell, was administered during the eighth month of treatment to account for pitch matching abilities. *PMM* required subjects to play their instruments against a recording of a single pitch, adjusting their fingers to match the pitch. Through analyzing each subject's deviations in cents from the recorded pitches, a pitch-matching performance score was found for *PMM,* the *Pitch Matching Index* (*PMI*). During the late spring, the *Intonation Performance Measure* (*IPM*) required each subject to play two eight-measure etudes similar to those

exercises found in the *Essential Elements* book. An analysis of each subject's deviations in cents from the standard frequency, this performance measure was recoded into the *Intonation Performance Index of Accuracy* (*IPIA*). The two performance-based measures, *PMI* and *IPIA*, were combined to create the *Intonation Performance Composite* (*IPC*).

Treatment type, *PDM* score, and prior musical experience served as independent variables in this study, allowing for several dimensions for analysis. *IPC* was the dependent variable. Data analysis revealed a significant main effect for treatment type on the *IPC* scores, only when the *IMMA* tonal test was a covariate. Subjects taught with the aural-based method had the highest mean scores, followed by the aural-based with tonal pattern enhancement, with the notation-based method producing the lowest mean scores. Significant differences in means were found between the notation-based method and aural-based method, as well between the notation-based method and aural-based with tonal enhancement method. No significant difference was found between the aural-based method and aural-based with tonal enhancement method. This data implies that students taught using the aural-based and aural-based with tonal enhancement methods performed with greater intonation accuracy than those taught using the notation-based method. The two aural-based methods emphasized aural skill training and vocalization activities.

Dell's study utilized two aural-based methods as treatments, incorporating singing and tonal pattern training into the beginning string classroom, in examining performance pitch accuracy. One notation-based method served as the control. She found that subjects participating in aural skills development exercises performed with greater instrumental intonation accuracy than those not utilizing these techniques, according to

pitch matching and pitch performance measures. In addition to aural skills exercises, it is possible that teacher differences and/or the difference in the number of days of weekly instruction played a role in the results of this study. Though the amount and consistency of instruction varied, Dell ensured that each of the five teachers diligently used their assigned treatment, as each teacher was observed and met on a regular basis with the researcher.

While Dell's study looked at singing and string playing performances, singing intonation was not examined nor was a direct relationship between singing and string playing intonation addressed. The present study will examine the relationship between singing intonation and playing intonation, without utilizing any form of treatment.

Summary

These studies demonstrate that the use of vocalization practice significantly improves tonal musical achievement. Elliott (1974) found that incorporating singing into a beginning band classroom improved the subjects' sense of pitch, including aural pitch discrimination. This finding does not describe performance accuracy. Harris (1977) found that an intonation training program incorporating vocalization of single pitches, intervals, scales, melodies, etc. significantly improved the instrumental performance pitch accuracy of junior and senior high band students. Schlacks (1981) found that a high school band interval training program incorporating both singing and playing of identical intervals improved the instrumental solo performance pitch accuracy of intervals more than singing or playing the intervals alone. Brick (1984), Smith & Brick (1990), and Smith (1995) found that a training program using pitch-matching singing exercises

improved the subjects' instrumental performance pitch accuracy. In addition, Smith & Brick (1990) and Smith (1995) found that this type of program also improved the subjects' aural pitch discrimination. Dell (2003) found that beginning string students taught with an aural-based or aural-based with tonal pattern method had significantly greater intonation accuracy than those taught with a notation-based method.

In examining these studies, it is apparent that the use of singing with instrumental students helps develop audiation skills and performance intonation. While it seems that there is a link between singing accuracy and playing accuracy, little research provides a correlation between these two factors. This study will further investigate the link between these variables.

Chapter III
METHOD

Subjects

The subjects for this study are 31 beginning violin and viola students currently studying violin or viola in an East Lansing Public Schools elementary school in East Lansing, Michigan. Twenty fifth-graders (5 male, 15 female) and 11 sixth-graders (5 male, 6 female) participated in this study. Students from two grades were needed to create an adequate sample size; the use of only one grade would not have provided enough subjects for a meaningful study. The school district under investigation is located in a medium-sized metropolitan area near a major university, which is one of the area's main employers. Many international students provide a culturally diverse environment in the region. This area is predominantly middle class, with a diverse range of income.

Violin and viola students were grouped together in this study because of their instruments' similar ranges. Letters of invitation to participate were sent home to the parents and/or guardians of all violin and viola students in the fifth-grade and sixth-grade classes (see Appendix A - 1). Students were also asked to give written assent to participate (see Appendix A - 2). Only those students who returned consent forms and gave written assent participated in the study.

The subjects received general music instruction from one of two teachers. These students met two times per week, each for 30 minutes, from kindergarten through fourth-grade. Instruction was sequential, and followed state guidelines. Both teachers incorporated singing, movement, and dance into their curriculum. One teacher also incorporated elements of Music Learning Theory (Gordon) into instruction.

The 31 subjects were students from two string classes of differing grade level. Each grade received instruction three days per week for 40 minutes. This instruction period included time for the students to unpack their instruments, have their instruments tuned by the teacher, and pack up their belongings before passing to their next class. Because of these activities, actual instruction time was less than 40 minutes. Both grades were heterogeneous in nature, including violin, viola, and cello players. The fifth-grade class contained 38 violinists, 7 violists, and 3 cellists, while the sixth-grade class contained 21 violinists, 6 violists, and 1 cellist. Those students who began to play through this school district began in heterogeneous classes in September of their fifth-grade year. Both classes were taught by the same teacher, who had been teaching in the public schools for approximately five years.

Fifth-grade students studied *Essential Elements 2000* from notation, as well as Level One unison concert pieces (learned by ear) in orchestra class. Students in this ensemble primarily used music that included the note names of each piece, instead of traditional music notation. The students were currently preparing tunes such as *Perpetual Motion*, *Dancing Sunbeams*, and the *MSU Fight Song* for an upcoming concert. These students were comfortable playing in the keys of D and G major, and using low 2^{nd} and 1^{st} fingers. Finger patterns using 1^{st}, 2^{nd}, and 3^{rd} fingers were becoming more consistently in tune. This group was working on new bow skills, such as slurs and hooked bows. They were also beginning to listen to one another and play as an ensemble.

Sixth-grade students primarily rehearsed Level 1½ - 2 concert pieces during orchestra class. These students were currently preparing tunes such as *Wabash*

Cannonball and *Fiddlin' Favorites* for an upcoming concert. They were comfortable playing a two-octave G major scale, incorporating the 4th-finger, and bowing with various techniques, such as marcato and détaché. Their intonation, sight-reading skills, identification of melody, and ability to play in two-part harmony were developing. As with the fifth-grade, these students were beginning to listen to one another and play more as an ensemble. They used both music with the note names and traditional music notation.

After tuning all of the students' instruments, the teacher began each class period by playing melodic patterns on her violin. These patterns, approximately three pitches in length, were to be echoed by the students on their respective instruments. These patterns incorporated many pitches and strings, sometimes including rhythm patterns. The teacher also picked sections from the concert pieces to strengthen bow technique. She concentrated on these patterns for only the first few minutes of each class period, devoting the remaining time to the rehearsal of concert pieces. The teacher played with her students for the majority of the class period, serving as a musical model. She would sometimes play the melody, on her violin, but quite often played a harmony part.

The atmosphere of the fifth- and sixth-grade classes was one of encouragement and fun. The walls of the classroom were decorated with pages of orchestral music, photographs and magazine clippings of famous musicians, and other musical topics. All participating students sat in chairs arranged in rows, facing the front of the classroom. The teacher moved quickly from one task/piece to the next to help keep their attention. The fifth-grade class was sometimes difficult to manage, as the teaching space was cramped, due to the large number of students.

Design

Thirty-one beginning violin and viola students participated in this study during their fifth- or sixth-grade year. This study took place in two phases during the late spring of 2006 (see Appendix B). During the first phase, the subjects were asked to sing a song individually and unaccompanied from the general music common literature. This phase gave the subjects an opportunity to become comfortable with the testing situation and an opportunity to sing alone. An experience authentic to the test situation was crucial because it is possible that some of the subjects may have had little prior solo vocal experience, and a subject's negative reaction to the test situation might adversely affect his or her performance. During the second phase, the subjects sang, as well as played, a different piece of common repertoire for both general music and string orchestra.

The unaccompanied exercises from the first phase were recorded by the researcher and a random sampling of these performances was evaluated by six judges to serve as a pilot test of the rating scale.[1] The unaccompanied exercises from the second phase were recorded by the researcher and evaluated by three judges; three vocal or general music judges and three string judges evaluated the recordings related to their field. An identical continuous rating scale was used to assess each subject's singing and playing intonation. The data from these scales were used to calculate the correlation between singing intonation and playing intonation.

[1] The rating scales of Dr. Cynthia Taggart, Music Education Professor at Michigan State University, were used as a departure point in developing the intonation rating scale used in this study.

Procedure

This study was approved by the East Lansing Public Schools on March 24, 2006. Approval from the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University was attained on April 10, 2006.

In the late spring, permission slips were given to approximately 45 fifth-grade students to be signed by their parents and/or guardians. Because a low number of these forms was returned after two weeks, the researcher chose to include sixth-grade students in order to increase the study's sample size and complete the project before the end of the school year. Permission slips were given to approximately 27 sixth-grade students to be signed by their parents and/or guardians. The combining of two grades was acceptable because of the nature of the study. Neither age group was necessarily at an advantage, because the task was well within the ability of each grade. Before the first phase of this study, each student was asked to give his or her written assent to participate. Only those students who turned in a signed consent form and expressed their assent were allowed to participate. Because the number of students turning in consent forms was low, students were tested in the order in which they returned the forms.

This study occurred during the late spring so that the subjects would have had an opportunity to acquire a good grasp on the technical facility needed to play the musical exercises on their respective instruments. Subjects were pulled out of string rehearsals in small groups. All subjects waited outside the testing room for their turn to take part in the study. A resource room and an art room down the hall from the orchestra room served as the testing sites. An Olympus brand Digital Voice Recorder DS-2 was used to

record all performances. Only the subject and the researcher were present during the testing sessions.

Six judges assessed the performances in this study: three judges familiar with fifth- and sixth-grade vocal development and three judges familiar with beginning string technique. A total of six judges was needed so that if the ratings of any judge were too extreme in either direction, his or her ratings could be dropped from that section of the study. All of the judges rated the Phase One singing performances because this phase only incorporated a singing exercise. However, the singing and playing performances from Phase Two were rated by separate sets of judges.

The Phase Two vocal performances were rated by three graduate music education students. These judges had previously taught choir or general music, between one and seven years, in public or private schools. The Phase Two instrumental performances were evaluated by three instructors from the Suzuki program at the Michigan State University Community Music School. These judges held a bachelors or higher level music degree, and had all been teaching strings a minimum of fifteen years. The judges were given approximately one week to rate the recordings from the first phase, and approximately one month to evaluate the recordings from the second phase.

Phase One

On the days of the Phase One recording sessions, all students who had returned a signed consent form that day waited outside the testing room after the researcher helped tune all of the students' instruments. Each student was called into the testing room individually, and then allowed to return to class after the session. During the first

meeting, the researcher gathered written assent and demographic information from each student before proceeding with the testing session. Each student was given time to read the assent form and ask questions before providing assent. After the consent and assent forms were completed, each subject answered questions about his or her previous musical experience. The researcher took notes on a form created for this purpose. The musical survey collected information such as instrumental experience and years of private study, as well as vocal participation outside of school (see Appendix C). None of the subjects' names appeared on these forms. The absence of each student's name was important because the information gathered from these surveys was intended to describe the subjects as a group, as well as notice any possible trends in the data analysis. Inclusion of their names on this survey would have eliminated student confidentiality. Instead, each subject's identification number, which was assigned at this time, was recorded on the form. These numbers were assigned according to the order in which the students entered the testing room. Each grade was separated, with fifth-graders given student numbers 1-20 and sixth-graders given student numbers 21-31. The researcher then answered any questions and explained the procedure of the testing session.

The subjects were asked to sing *Row, Row, Row, Your Boat* individually (see Appendix D – 1 & 2). This piece has a range of one octave and was used because it was a vocally familiar song. Each subject was asked if he or she would like to see the music notation and text, when applicable. This was provided when the subject desired. Before being recorded, each subject was allowed to look briefly at the music notation, if he or she chose to use it. Once the researcher began the recording process, the subject stated his or her student number so that the performances of each subject could be organized.

Because student identity was held confidential in this study, each subject only recited his or her student number on the recordings. The names of the students were only recorded on the consent and assent forms. Then the harmonic context for the exercise was played by the researcher on an electric keyboard. A tonic-subdominant-dominant-tonic (I-IV-V7-I) chord progression was played, followed by the first pitch of the exercise played by the researcher on the keyboard. The chord progressions were programmed into the researcher's Yamaha DGX-200 Portable Grand, thus insuring that each subject would hear an identical chord progression.

The first 14 subjects that participated in this study, all from the fifth-grade, were given a harmonic context for the key of D major. However, after analyzing these recordings, the researcher discovered that while many of the students began on the preferred starting pitch, if the subject began on a different pitch or sang in a different key, it was consistently lower. This suggests that the subjects' singing voices were not yet developed enough to sing the higher pitches. Thus beginning with subject 15, the harmonic context was lowered to the key of B-flat major (see Appendix D – 3 & 4). Also, the researcher no longer only played the harmonic context and starting pitch on the keyboard, but also sang the starting pitch to the student, with the words," One, two, ready sing." This addition to the procedure was needed because the subjects may have had a difficult time transferring the keyboard pitch to their voices.

The subjects sang the song twice. An identical procedure was used for each of these two trials, with the only change being the manner in which the song was performed. The song was sung one time using a neutral syllable or hum, and one time with the words. The researcher gave the subjects a choice between using a neutral syllable or

humming so each subject could be as comfortable as possible. Because the purpose of this phase was to investigate the effectiveness of the rating scale, this option was acceptable even though humming may have made some pitches more difficult to produce than singing on "bum" or "la." To control for a possible effect of order, half of the subjects sang with the words first, while the other half sang using a neutral syllable first. The order of the text and no-text performances alternated for each subject, as he or she entered the testing room. Two trials for the song were needed to determine if it was developmentally appropriate for the subjects to attend to both the melodic and lyrical requirements of the song. Because this study examined intonation, producing accurate pitches was more important than producing correct text.

The first phase of this study served three purposes: (a) to give each subject an experience authentic to the testing situation in order to prepare them for the second phase; (b) to determine the song performance condition, text or no text, for the second phase; and (c) to pilot the rating scale. During the recording sessions, the researcher also recorded whether the subjects wanted to use the notation, and whether each subject chose to look at the music he or she was given.

At the conclusion of Phase One, each judge received a packet of information to assist in the judging process. The Phase One packet included: a cover letter, a form to gather demographic information about the judges, a form to record their hours of work for the project, a sheet to record the ratings for each subject, and a CD of 10 randomly selected performances. The intonation rating scale was also included (see Appendix E – 1). The cover letter explained that, because intonation was the only factor under

investigation in the study, other aspects of the subjects' performances, such as rhythm or expression, were to be disregarded.

The CD in each packet was a recording of 10 vocal performances of *Row, Row, Row Your Boat*, which were randomly selected from the first 14 fifth-graders that participated in the study. Five of the performances included the words, while five contained no words. While only 14 subjects were candidates for the first CD evaluated by the judges, all participating subjects continued to be recorded, without being rated, to increase their familiarity with the procedure and to give them experience with singing in solo.

Phase Two

On the days of the Phase Two recording sessions, the researcher helped tune all students in the class before bringing three subjects from the rehearsal room to the testing site. These students waited outside the testing room before their individual sessions, and sent another student to the testing room upon returning to class. This procedure ensured that the students would be present in orchestra for the maximum amount of time possible. During this phase, the researcher matched each subject in the testing room with his or her student number recorded on each subject's consent form, to ensure that the subjects participating in the second phase were the same subjects from the first phase. The researcher then explained the testing procedure and answered any questions. Before performing either vocally or instrumentally, each subject was asked if he or she would like to see the traditional music notation or note names. When given this choice, all subjects preferred to use one of the forms of notation. During the first phase, all but five

of the subjects wanted to use the notation. Even though the song was familiar, most of these subjects looked at the notation while being recorded. Therefore, all subjects were again given the option of using notation in the second phase.

Yankee Doodle was used in the second phase of the study because it was of common repertoire for both general music and string orchestra. The piece did not exceed the vocal range of a fifth- or sixth-grade singer, or the technical capability of a beginning string player. The selection included a leading tone, which helped establish a sense of tonality. It was acceptable for *Row, Row, Row Your Boat* to not include a leading tone because this song was used for the initial phase, in which the data was not used to answer the research question. *Yankee Doodle* was sung in E-flat major (see Appendix F – 1), and played in G major (see Appendix F – 2 & 3). The use of different keys was acceptable because each served an appropriate role in the study: E-flat major provided an appropriate vocal range for each subject, while G major provided appropriate finger patterns for a beginner's playing ability.

While *Yankee Doodle* was part of the general music repertoire in the early elementary grades, it was not familiar as an instrumental piece. The researcher taught the tune to all students in the two orchestra classes. This session took place two class periods prior to the beginning of the second phase of the study, giving the subjects instrumental familiarity with the tune. Sight-reading the instrumental version could have produced inaccurate results as the students may have attended to the unfamiliar notation more than intonation, which was the focus of this study. Sight-reading was not a variable under investigation.

The subjects were asked to sing and play *Yankee Doodle* individually. This song has a range of a minor seventh, and was part of the students' repertoire. After analyzing the performances from the first phase, the researcher discovered that there was not a noticeable difference in intonation accuracy between trials with words and without words. Therefore, the subjects were asked to sing the song with the words. Half of the subjects performed *Yankee Doodle* vocally first, and half performed the song instrumentally first, alternating according to the order in which each subject entered the testing room. The subjects sang the song one time, and played it two times. The instrumental exercise was played two times to allow each subject's fingers to warm-up and become accustomed to forming the correct finger patterns. Not allowing this time might have weakened the results if the subject needed an opportunity to prepare the fingers to execute the pitches notated in the music. Only ratings from the second trial were used in analyzing the data from this study.

Once the recording process began for the vocal performances, the subject stated his or her identification number, and then listened to the harmonic context for the song played by the researcher's keyboard. A tonic-subdominant-dominant-tonic (I-IV-V7-I) chord progression was played, followed by the researcher playing the first pitch on the keyboard, and singing "One, two, ready sing" on the starting pitch. The subject then sang the exercise one time alone. The chord progressions for each exercise were programmed into the researcher's Yamaha DGX-200 Portable Grand, thus insuring that each subject would hear an identical chord progression.

If the student sang the exercise first, he or she was then asked to play the same selection on his or her respective instrument. The researcher tuned each instrument to the

A-pitch found on the same keyboard that produced the harmonic context for the vocal selection. This pitch was programmed into the keyboard, along with all harmonic contexts for the study. Each student was given a choice between two types of notation: traditional notation or note names (as used in class in addition to traditional notation, see Appendix F - 4). Each subject was allowed to look at the notation for a short moment before the recording process. Once the recording began, the subject stated his or her identification number so that the performances of each subject could be organized. Then a tonic-subdominant-dominant-tonic (I-IV-V7-I) chord progression, previously programmed into the researcher's keyboard, was played. The first pitch of the exercise was then played by the researcher on the keyboard. All pitches that could be played with an open string were marked as such on the traditional notation. Each subject was asked to use these open strings for their instrumental performance to ensure similar fingerings between the subjects. All subjects followed this request. The subject was then asked to play the exercise in solo, twice. The subject stated his or her student number and listened to the harmonic context and first pitch for both instrumental performances. Both trials were recorded to provide consistent conditions.

At the conclusion of Phase Two, each judge received a packet similar to the Phase One packet, with a few alterations. Changes to the packet included the addition of the traditional notation and note names for *Yankee Doodle*, inclusion of either the vocal or instrumental performances on the CD, and a change to the rating scale (See Appendix E - 2). The intonation rating scale was slightly altered to specify the rating of the instrumental performances. The sung performances and the second instrumental trial performances were rated from this phase.

All recordings were downloaded from the digital recorder into the DSS Player Software on the researcher's desktop computer. The files were then labeled and uploaded into I-Tunes. The WMA format for each of the files was converted to AAC format so the performances could be played and burned onto a CD through I-Tunes.

Analysis

At the conclusion of Phase One, the interjudge reliability among all six judges was determined. This phase served to determine if all six judges interpreted the rating scale in a similar fashion. An interjudge reliability coefficient for the rating scale needed to result in a reliability of .70 or higher before Phase Two could occur, as that level represents sufficient reliability for a single dimension of a rating scale. After receiving the ratings from the judges, the researcher discovered an acceptable correlation for Phase Two to take place.

At the conclusion of Phase Two, the interjudge reliabilities among the vocal and string playing judges were calculated. Two interjudge reliability coefficients were determined: one reflecting the singing exercise, and the other reflecting the string playing exercise. Because the reliability of the string playing judges was much lower than expected, a second group of string playing judges was trained to rate the same string playing performances.

A Pearson product-moment correlation was used to determine the relationship between two variables: performance pitch accuracy of singing and performance pitch accuracy of playing a string instrument. If a strong positive correlation was revealed, it could be said that there is a meaningful relationship between the two variables.

Chapter IV
RESULTS AND INTERPRETATION

This study investigated the relationship between singing intonation and playing intonation in beginning violin and viola players. Thirty-one subjects participated in two phases. Data from the first phase were used to pilot test the rating scale, while data from the second phase were used to answer the problem of the study. During the first phase, six judges evaluated the intonation of a common repertoire song sung by each subject. During the second phase, the subjects both sang and played a different song from their common repertoire. Three vocal judges rated the sung performances and three string playing judges rated the instrumental performances. A continuous rating scale (1-5) was used during both phases.

The following statistics were calculated: (a) interjudge reliability of the judges' ratings for Phase One, (b) interjudge reliability of the judges' ratings for Phase Two, (c) means and standard deviations of the Phase Two singing and string playing ratings, and (d) the correlation between singing and playing intonation.

Interjudge Reliabilities

Interjudge reliability was calculated between all six judges participating in the first phase of the study. These correlations were used to establish the reliability of the study's rating scale. The Pearson product-moment correlation coefficient among all of the judges (Judges A, B, C, D, E, and F) was 0.92 (see Table 1). This strong direct relationship suggests that the judges interpreted the rating scale similarly. This high interjudge reliability allowed the researcher to proceed with Phase Two of the study.

Table 1. Phase One Judge Reliabilities*

	A	B	C	D	E	F
A		0.91	0.91	0.91	0.94	0.92
B			0.93	0.92	0.91	0.89
C				0.94	0.86	0.89
D					0.93	0.93
E						0.96
F						

**Note.* Each letter (A-F) represents one judge

The judges from Phase One were also involved with Phase Two of the study. Three vocal judges and three string playing judges evaluated the performances from Phase Two. The Pearson product-moment correlation coefficient for the three vocal judges (Judges A, B and C) was 0.79 (see Table 2), and 0.55 for the three string playing judges. Acceptable reliabilities were found for the vocal judges, and low reliabilities were found for the string playing judges. Due to the string playing judges' reliability under 0.70, a second analysis of the string playing trials occurred with a different set of judges (Judges G, H, and I).

Table 2. Phase Two Vocal Judge Reliabilities

Judges	*Correlation*
A & B	0.80
A & C	0.77
B & C	0.81
Composite	**0.79**

Three students from a local university re-evaluated the Phase Two performances. All three judges were string instrumentalists studying music education. All had previous teaching experience between 4 and 13 years, including Suzuki and private teaching, fiddle ensembles, and various levels of string ensembles. These judges participated in a more detailed training session regarding the rating scale before analyzing the instrumental performances.

The Pearson product-moment correlation coefficient found for the second set of three string playing judges was 0.69 (see Table 3). The data from this study continued to be analyzed using the ratings from this set of judges.

Table 3. Phase Two String Playing Judge Reliabilities

Judges	*Correlation*
G & H	0.68
G & I	0.69
H & I	0.69
Composite	**0.69**

Means and Standard Deviations

To determine the means and standard deviations of the singing and playing ratings for each subject, a composite score was determined for both variables of the study. The ratings of the three vocal judges were added, as well as the second set of string playing judges' ratings. As a result, the composite scores for both vocal and string playing intonation consisted of a combination of three ratings. Because a continuous rating scale (1-5) was used, the composite scores ranged from 3 to 15.

The theoretical mean of the composite scores was 9, and the theoretical standard deviation of the composite scores was 2. The observed mean of the vocal composite scores was 8.65, and the observed mean of the string playing composite scores was 9.13. The observed standard deviation of the vocal composite scores was 3.35, and the observed standard deviation of the string playing composite scores was 2.50. A comparison of the observed composite means and standard deviations indicates that the string playing scores are slightly higher than the vocal scores, and that the string playing scores also have less variance than the vocal scores (see Table 4). The vocal observed standard deviation was much higher than the theoretical standard deviation, meaning that the variance in that distribution was much larger than expected.

Table 4. Theoretical and Observed Means and Standard Deviations

	Theoretical Mean	*Observed Mean*	*Theoretical SD*	*Observed SD*
Vocal	9	8.65	2	3.35
Instrumental	9	9.13	2	2.50

Relationship between Singing Intonation and Playing Intonation

The Pearson product-moment correlation coefficient found between the vocal and string playing composite scores was 0.41. This value was found to be statistically significant ($p < .05$). This correlation is of moderate strength.

Interpretation

The primary concern of this study was to determine the extent of the relationship between students' singing and string playing intonation. The strong interjudge reliability from Phase One suggested that a similar interpretation of the rating scale existed between the judges. Therefore, no additional instruction was given to the judges prior to rating the vocal and instrumental performances of Phase Two. However, the interjudge reliabilities from Phase Two were lower than those found from Phase One; the coefficients for the vocal and string playing judges were 0.79 and 0.55, respectively. A second group of judges was assembled and given additional instruction on use of the rating scale. With these added instructions, the second set of string playing judges produced an interjudge reliability of 0.69. While this value was moderate, it was interpreted that these judges were able to distinguish between the criteria of the rating scale more clearly due to the additional explanation. It is also possible that the difference in reliabilities may be a result of the rating scale only being valid for rating a sung performance.

The correlation between singing intonation and playing intonation was found to be 0.41. This relationship is statistically significant at the 0.05 level. This suggests that the two independent variables in this study are related. A larger sampling of students from various communities might have provided results to make this relationship even

more clear, as well as increase the interjudge reliabilities. If a stronger interjudge reliability were to be achieved, it is possible that the relationship between singing and playing intonation could be stronger.

This study combined the data from subjects of two grade levels for analysis. While it was apparent that two different levels of string playing existed, an assumption was made that vocal pitch accuracy improved at the same rate as string technique. It is possible that the subjects' singing skills remained constant, declined, or did not improve at the same rate as their string playing skills. The assumption that singing and string playing skills improve simultaneously has not been tested; further research is needed to confirm this notion.

Another limitation to this study may be the kinesthetic difficulty of playing in tune on a string instrument. The key of D major was chosen for *Yankee Doodle* because finger patterns from this key are often the first to be learned on the violin and viola. The researcher presumed that first and second year string players would be proficient in this key; however, it is possible that aural pitch perception and performance pitch accuracy may differ because of technical problems.

A group of subjects with varied abilities and skills is preferable in research. Testing for music aptitude is one way to determine if a diverse distribution of subjects exists. The researcher assumed that the diversity of the subjects' musical abilities, as well as their vocal and string playing skills, would reveal itself through their performance ratings, as confirmed by the observed standard deviations. Also, though aptitude was not accounted for, a limited amount of musical background information was acquired from each of the 31 subjects. The Music Experience Survey (see Appendix C) completed at

the beginning of Phase One indicated that the subjects had widely varying musical experiences.

Chapter V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to develop an understanding of the relationship between singing intonation and string playing intonation in beginning instrumentalists. The specific problem of this study was to examine the relationship between singing intonation and playing intonation in fifth- and sixth-grade violin and viola players. Because their instruments have similar ranges, violinist and violists were incorporated into a single group.

Thirty-one beginning violin and viola players from one mid-Michigan elementary school were subjects in this study. These students were in their first or second year of public school string instruction. This investigation took place in two phases. During the first phase, each subject was asked to sing *Row, Row, Row Your Boat* alone and unaccompanied. This practice performance allowed each subject to become acquainted with the testing procedure and practice singing alone, as it was possible that not all of the subjects may have had this experience. Recordings from these performances were evaluated by six judges with an intonation rating scale developed for this study. The interjudge reliability found for the rating scale with these performances was 0.92. This strong direct relationship allowed the next phase of the study to proceed.

Prior to the second phase, subjects were taught *Yankee Doodle* during one of their large string classes. This song was introduced in the large group because, though it was part of the early general music curriculum, some of the students may not have experienced the tune with their instruments. It was important for *Yankee Doodle* to be

familiar for both the voice and instrument. During the second phase, each subject performed this song both vocally and instrumentally. The vocal recordings from these performances were evaluated by three vocal judges, and the instrumental performances assessed by three string playing judges.

The interjudge reliability for the vocal judges was 0.79, while the string playing judges produced a reliability of 0.55. Due to the low string reliability, the instrumental performances were rated a second time by three different judges. These judges received additional training on the use of the rating scale. The interjudge reliability for the second set of string playing judges was 0.69. With this new, but still moderate reliability, the data continued to be analyzed.

Composite scores were calculated from the three vocal judges' ratings, and the second set of string playing judges' ratings. The Pearson product-moment correlation coefficient found between these two sets of scores was 0.41. This value was found to be statistically significant at the 0.05 level of significance. Thus, this study revealed a direct relationship between singing intonation and string playing intonation for this study's population.

Conclusions

A statistically significant result was found between singing intonation and string playing intonation. Though this finding cannot be generalized to all beginning string students, it suggests that there is a link between singing in tune and playing in tune. More research needs to be done in this area.

A review of experimental studies incorporating singing with instrumentalists suggests that the introduction of vocalization activities can improve playing intonation. Harris (1977), Schlacks (1981), Brick (1984), Smith & Brick (1990), Smith (1995), and Dell (2003) found that incorporating singing activities within the classroom or individually with a pitch-matching program improved instrumental performance pitch accuracy. The results of the present study lend additional weight to those conclusions and to the idea that, "if you can sing in tune, you can play in tune" (J.A. Palac, personal communication, November 15, 2005).

Gordon's aural/oral transfer theory states that a person's pitch perception transfers to his or her performance pitch accuracy. The instrument is viewed as an extension of the human body, an extension of the musical voice. The findings of the present study further support this concept, because a direct relationship was found between singing pitch accuracy and string playing pitch accuracy.

Implications

Research suggests that the inclusion of singing in an instrumental classroom strengthens student instrumental intonation. Though instrumental facility and musicality is a prime concern for string teachers, the addition of singing should be considered. Therefore, string teachers must not only feel comfortable correcting string intonation, but vocal intonation as well. If singing and playing coexist in the string classroom, the teacher must not only be well trained in instrumental strategies, but also in basic singing production. It is possible that if singing in tune continues to be fostered beyond general

music class, its benefits may transfer to playing ability, thus improving instrumental intonation.

This type of intonation work could potentially reduce the amount of time spent working on intonation in a strings class. Detailed intonation work is often a tedious process for either a class or an individual. Any shortening of the duration of this task would allow more instruction time for other musical activities. Though additional instruction time is not a direct benefit of singing in tune, it may act as a side benefit.

The importance of developing the singing voice is suggested in previous studies, as vocal ability often transfers to instrumental ability. This study reinforces the idea that a relationship between singing and playing intonation exists. These results provide implications not only for the instrumental classroom, but for the vocal classroom as well. This information gives general music teachers one more reason to develop performance pitch accuracy in their students. This attention to vocal intonation should continue into the instrumental classroom.

Suggestions for Future Research

The population in this study was small (n=31) and was drawn from one elementary school building. It is recommended that this study be repeated with a larger population, including several different grades from various schools and communities. A comparison of subjects from elementary, junior high, and high school would strengthen the possibility of these results being transferred to a larger population. Data from this type of study would first be analyzed separately by grade level.

The rating scale used in this study could be revised to provide greater interjudge reliability. Both vocal and string playing judges might use this rating scale to evaluate all performances, not only those from their area of specialization. This study might also be repeated without the use of a rating scale. Instead, technology could be used to measure the frequencies of each pitch, providing a more objective measurement of intonation. Pitch tendencies, such as the seventh degree of a key played on the high side of the pitch, would need to be considered, which would complicate the task. This type of study might also investigate if string players tend to play with a specific tuning system. Salzberg (1980), among other researchers, suggests that string instrumentalists tend to play sharp and play closer to Pythagorean intonation than to equal temperament. More research could be done to investigate this suspicion.

The subjects of the present study played instruments of similar registers; only violin and viola players were involved in this study. The ranges produced on these two instruments were identical for the instrumental performance, and similar to the range of the vocal performance. It is recommended that a study examine the relationship between vocal and instrumental intonation with cello and double bass players. While both Smith (1995) and Dell (2003) included cello and double bass players in their studies, neither reported the results from these specific instruments. A study examining the relationship between singing and playing intonation of elementary students beginning to play the cello and double bass is recommended. It is unclear if the register difference would hamper, improve, or have no effect on performance accuracy.

Subjects in this study performed *Yankee Doodle* in E-flat major for the vocal trial and in G major for the instrumental trial. These keys were chosen because they provided

an appropriate singing range and familiar finger patterns. Choosing different keyalities might be investigated. If a subject can sing a song in tune, might he or she also be able to play the same tune on his or her instrument in an unfamiliar key? In other words, given a familiar melody in a keyality with an unfamiliar finger pattern or position, would the subject be able to correct his or her intonation if given time to become acquainted with the task?

Perhaps playing and singing in tune is more than a product of inner hearing which transfers to performance. For some instrumentalists, technical facility at an instrument is a challenge. For example, the researcher noticed problematic intonation when the second-finger was used. This difficulty may play a role in playing in or out of tune. This study suggests that research examine whether playing in tune or out of tune is not only an audiation issue, but also a mechanical issue. It is also recommended that research be done to examine the correlation between the kinesthetic abilities of string players at various grade levels and their performance pitch accuracy.

Previous studies examining instrumental intonation include vocalization exercises as a type of treatment. These studies suggest the positive effect of vocalization activities upon instrumental performance pitch accuracy. While many studies evaluate playing intonation immediately following a treatment period, subjects might instead be tested a month or more after the conclusion of the treatment. Researchers might discover if students only improve their instrumental performance accuracy during a treatment period of singing, or if this improvement is sustained for a longer period of time, thus continuing to improve their instrumental intonation. Such a study might determine the correlation

between singing and playing intonation immediately following a treatment period, as well as at a later time after the study is complete.

Final Thoughts

On an early Monday morning, a teacher introduces a piece in the key of B-flat major to a group of beginning string students. While they are familiar with the tune, *Perpetual Motion,* and have played it in various keys, the finger patterns for B-flat major are still unknown. However, these students are familiar with the G, D, and A major finger patterns found on all four strings of their instruments. Before playing, the teacher sings a portion of the melody to the class. The students participate by echoing back these phrases. Though these singing activities last for only a few minutes, there is sufficient time for out of tune singing to be corrected. The starting pitch is then introduced on the instruments. Once the students have found this pitch, the teacher holds her breath, and cues the students to play. Though errors occur, the students correct many of these intonation mistakes before their second attempt. The teacher is impressed at the ease in which these students play in B-flat major. Reflecting upon her own education, she realizes that these students are much more attentive to their playing than when she was a beginning string player.

In this situation, much traditional intonation work was avoided because the students were able to transfer their singing ability to an instrumental task. By altering traditional string instruction, this teacher efficiently improved musical skills. Perhaps this technique will be realized in other string classrooms, guiding more students to playing in tune.

APPENDICES

APPENDIX A

Consent Documents

APPENDIX A-1

Dear parent or guardian: April 3, 2006

I am a Masters of Music Education student at MSU doing a study on the relationship between singing intonation and playing intonation for my thesis. I am asking your permission for your student to participate in this study. This research will require each student to both sing and play his/her instrument alone. I will see your student two times during this study. Each time he/she will be taken out of orchestra class for 5-10 minutes. Because this research deals with singing and playing in-tune, both meetings will be audio recorded. If you are not comfortable having your child's musical performance audio-taped, please do not volunteer for this study. Your student's privacy will be protected to the maximum extent required by law. Recordings will be destroyed three years after the study has been completed.

Your student may experience nervousness or become self-conscious when asked to sing and play for me. However, this emotion should pass quickly. A friendly testing environment will be provided to help ease any possible anxiety. It is also possible that your student may experience an increase in solo performance self-confidence. Students will demonstrate the tasks in a private room, and these performances will not be shared with his/her classroom teacher. Participation in this study may help improve music instruction for future students.

Your student will be asked to provide demographic information, such as years of instrumental participation, as well as be asked to give written assent before the first meeting. Your student will only participate if both your written consent and his/her written assent are attained. Participation in this study is strictly voluntary. Your student may refuse to participate in all or part of the study, or refuse to answer particular questions, without being penalized.

If at any time you or your student have questions about this study, please feel free to contact me or Dr. Judy Palac, Responsible Project Investigator, at the address below. If at any time you or your student have questions regarding their rights as subjects of research, please contact the Institutional Review Board (IRB) at Michigan State University:

Human Research Protection Program
Peter Vasilenko, Ph.D., Director
205C Olds Hall
Michigan State University
(517) 355-2180
irb@msu.edu

Dr. Judy Palac
Responsible Project Investigator
203 Music Practice Building
Michigan State University
(517) 355-7665
palac@msu.edu

Your signature below indicates your voluntary agreement for your student to participate in this study and be audio recorded.

_____ _____
(signature) (date)

Your student's name _____ Student number _____
(please leave blank)

Sincerely,

Heather Frank
(218) 329-7560
frankhe1@msu.ed

This consent form was approved by the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University. Approved 04/10/2006 – valid through 04/09/2007. This version supersedes all previous versions. IRB # 06-190.

APPENDIX A-2

Dear student, March 15, 2006

I would like you to help me with a research project during your orchestra class period. I will see you two times. The first time I see you, I will ask you to sing *Row, Row, Row Your Boat* by yourself. The second time I see you, I will ask you to both sing, and play *Yankee Doodle* on your violin/viola. During these meetings, you will be alone in a room with me and tape recorded. It is possible that you may become nervous singing and playing by yourself in front of me. However, I will try to provide a friendly environment for you so this feeling will not last long. Your performance during these meetings will in no way affect your grade or place in your orchestra class, and will not be shared with your teacher. You may withdraw from this study at any time.

I would really appreciate your help!

Thank you,

Heather Frank
(218) 329-7560
frankhe1@msu.edu

Would you like to participate? Yes No (Please circle one)

_____ _____

(signature) (date)

Student's name _____ Student number _____

(please leave blank) (please leave blank)

This consent form was approved by the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University. Approved 04/10/2006 – valid through 04/09/2007. This version supersedes all previous versions. IRB # 06-190.

APPENDIX B

Timeline of Study

APPENDIX B

Timeline of Study

The timeline below describes this study's organization, from approval to completion.

March 24	Receive District Approval
April 10	Receive SIRB Approval
April 13	Handout consent forms to fifth-grade
April 18 – May 1	Phase One Recording Sessions (fifth-grade) – six class periods
April 27	Handout consent forms to sixth-grade
	Phase One Judge Materials compiled
April 28 – May 4	Phase One Recording Sessions (sixth-grade) – three class periods
May 4	Fifth- and sixth-graders taught *Yankee Doodle* by the researcher
May 8 - 15	Phase Two Recording Sessions (fifth-grade) – three class periods
May 8 - 11	Phase Two Recording Sessions (sixth-grade) – two class periods
May 16	Phase Two Judge Materials compiled
September 23	Phase Two Judge Materials compiled for second set of string playing judges

APPENDIX C

Music Experience Survey

APPENDIX C

Musical Experience Outside of School

Do you play an instrument?

Instrument	Years played	Years of private lessons
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Have you been in a choir outside of school?

Location (church, CMS, etc.)	Years
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

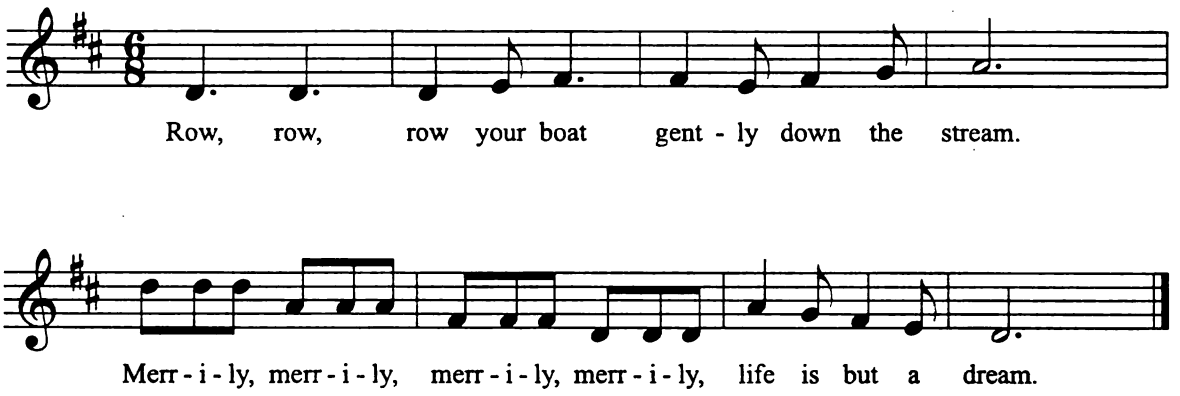
Student number _____

APPENDIX D

Phase One Musical Examples

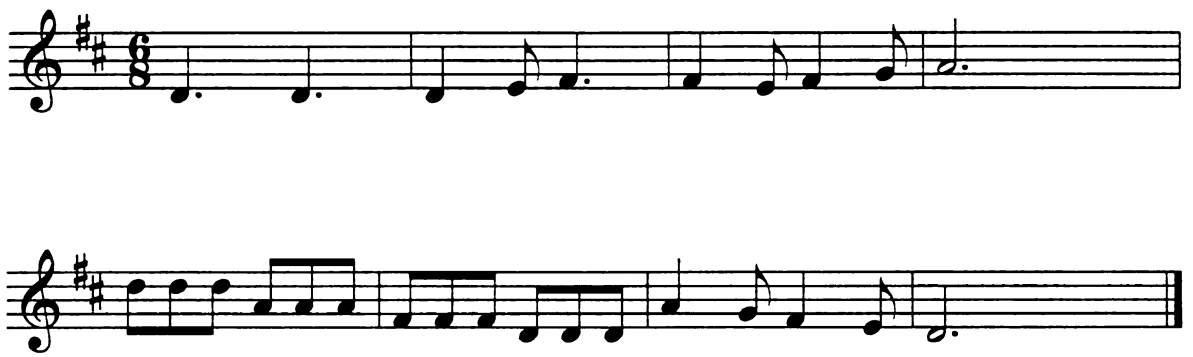
APPENDIX D - 1

Row, Row, Row Your Boat



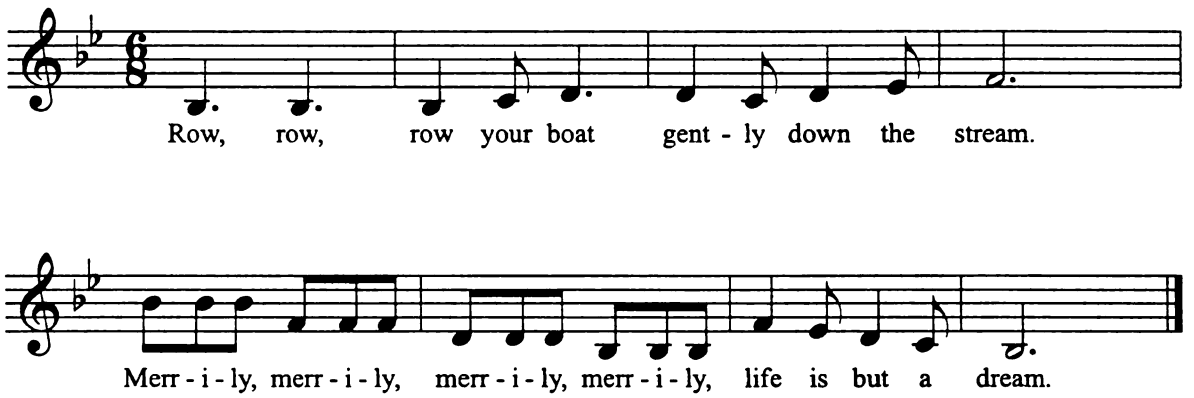
APPENDIX D - 2

Row, Row, Row Your Boat



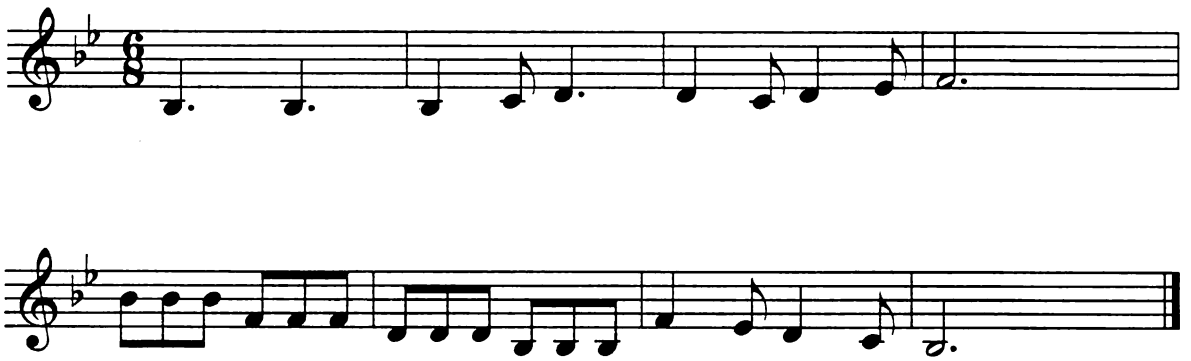
APPENDIX D - 3

Row, Row, Row Your Boat



APPENDIX D - 4

Row, Row, Row Your Boat



APPENDIX E

Rating Scales

APPENDIX E – 1

Intonation Rating Scale (continuous rating scale)

1 The subject has not found singing voice, or does not play any notes in tune.

2 The subject maintains melodic contour but loses tonal center.

3 The subject sings/plays with 3-5 intonation mistakes but generally maintains tonality.

4 The subject sings/plays with 1-2 intonation mistakes.

5 The subject sings/plays the entire exercise in tune.

APPENDIX E – 2

Intonation Rating Scale (continuous rating scale)

1 The subject has not found singing voice, or does not play any notes in tune.

2 The subject maintains melodic contour but loses tonal center, or maintains tonality other than that to which the strings are tuned.

3 The subject sings/plays with 3-5 intonation mistakes but generally maintains tonality.

4 The subject sings/plays with 1-2 intonation mistakes.

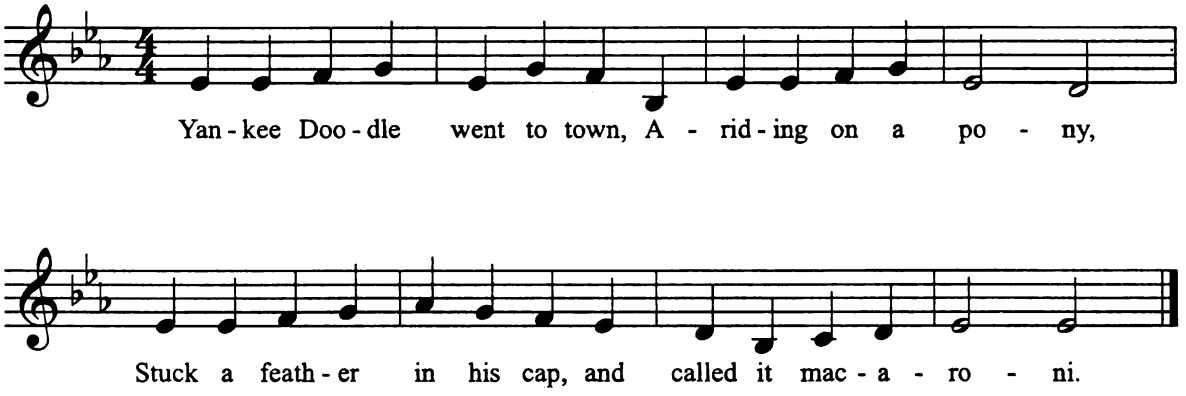
5 The subject sings/plays the entire exercise in tune.

APPENDIX F

Phase Two Musical Examples

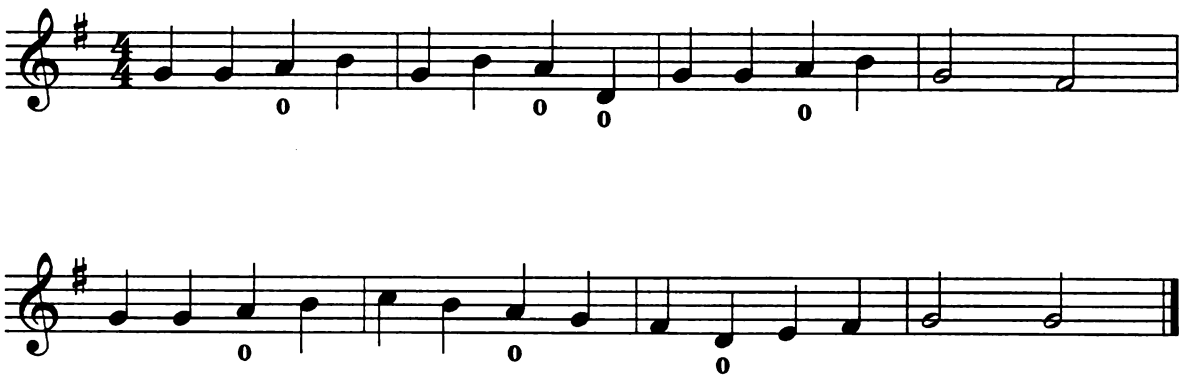
APPENDIX F - 1

Yankee Doodle



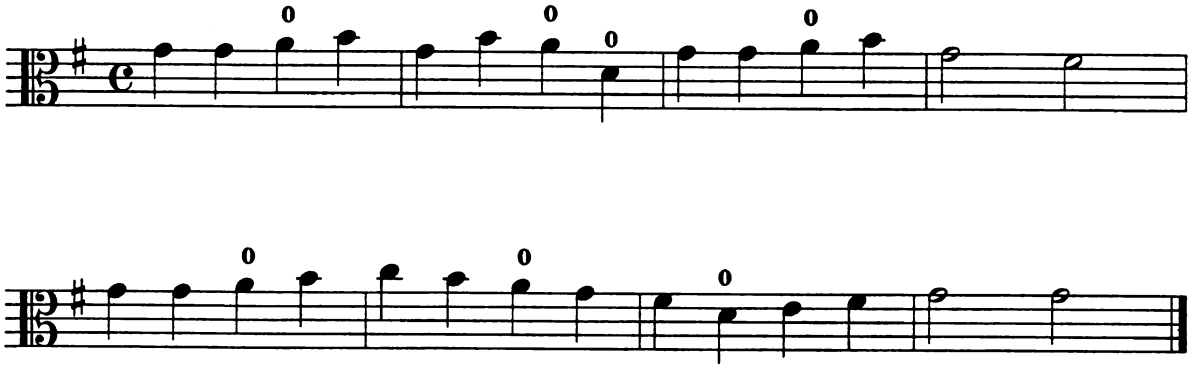
APPENDIX F- 2

Yankee Doodle



APPENDIX F - 3

Yankee Doodle



APPENDIX F – 4

Yankee Doodle

G G A B

G B A D

G G A B

G - - F♯ - -

G G A B

C B A G

F♯ D E F♯

G - - G - -

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