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Effects of Tonic Drone and Singing on the Pitch Accuracy of Middle and High School String Players

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EFFECTS OF TONIC DRONE AND SINGING ON THE PITCH ACCURACY OF MIDDLE AND HIGH SCHOOL STRING PLAYERS

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ABSTRACT

The purpose of this study is to determine the effects of tonic drone, and tonic drone and singing on the intonation accuracy of middle school and high school string students in a classroom setting. Participants (*N*=58) in the study included middle and high school string players from two school districts in northern Mississippi. Tonic drone (*n*=22) and tonic drone and singing (*n*=36) groups were comprised of one middle school and one high school class each. One group performed pitch–matching exercises that include a tonic drone while the second group performed pitch-matching exercises that included the tonic drone and singing. A pretest and posttest were given to determine intonation accuracy prior to and following treatment. Three pitches, E, F-sharp, and G were addressed during the three-week treatment period. Analysis of collected data using repeated measures SPANOVA testing found no significant interaction between groups from pretest to posttest. Neither the tonic drone or the tonic drone and singing group showed significant positive improvement in pitch accuracy. T-tests indicated the drone only group was statistically more accurate when posttest scores were compared. Future study should extend the length of treatment.

Keywords: tonic drone, singing, audiation, intonation, strings

DEDICATION

First and foremost, this dissertation is dedicated to close family members who have supported me throughout my educational pursuits. In particular, my father Starkey Morgan, Sr., mother Martha Morgan, sister Lorraine Cotten, and brother Walter Morgan have always been there for me.

Also, this dissertation is dedicated to the countless educators who have helped shape my musical career from the moment I began studying music. You have all become a part of the educator I am and hope to be, and your instruction will always be with me to share. I can't thank you all enough for your patience and dedication to your field.

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CHAPTER I

INTRODUCTION

The ability to play in tune is one of the most important skills music teachers can impart to their students (Silvey et al., 2019). Stringed instruments, unlike most wind instruments taught in public schools, lack keys as aids in producing accurate pitch (Morantz, 2016), possibly delaying development of this skill. In my own experience, I have found the lack of a standardized method of addressing intonation to be a significant issue in the string music classroom.

The present study investigated the effects of (1) hearing a tonic drone then matching the tonic drone on the instrument and (2) hearing a tonic drone, singing the tonic drone, then playing the tonic drone on the intonation accuracy of string musicians involved in middle and high school orchestra.

My journey into investigating methods of addressing intonation in the orchestral classroom began with a research project for a graduate school course. The study included a survey in which I asked public school string teachers, as well as private instructors, to share their views on teaching intonation. To my surprise, the responses were anything but consistent.

With this inconsistency in mind, I decided to administer a pilot study in the fall of 2019. The purpose of that study was to determine if singing a pitch after hearing it would improve the intonation accuracy of elementary-aged string students. Over the course of three weeks, an experimental group was administered a treatment which included a drone, singing the drone pitch using the syllable “la”, and playing the same pitch on their instrument with a bow. A control group received no treatment. Although neither group showed a statistically significant improvement in pitch accuracy, the group receiving treatment improved in pitch accuracy over the course of the three-week study (Morgan, 2019).

The research I performed for the current study was similar to the pilot project. The singing variable “la” was retained for treatment for the tonic drone with singing group. A continuous drone and an audible metronome at 60 beats per minute was also included in the treatment. The tonic drone group performed exercises using the continuous drone and the audible metronome but did not perform the singing variable “la.” Drone pitches originated from the program Online Tone Generator (https://onlinetonegenerator.com), which produced pure tones. Specific pitches used were E4, F-sharp 4, and G4. Due to the tendency of beginning string students in the public-school classroom to delay use of the bow for producing sound, changes included the participation of middle school and high school students rather than elementary-aged students. In addition, the number of participants (N=58) was larger than that employed in the pilot study.

Statement of Purpose

This study investigates the effects of tuning conditions on the intonation accuracy of middle school and high school orchestral string students. The tuning conditions for the tonic drone group include a metronome, a sustained drone, and pitch production on their instrument using the bow. The tuning conditions for the tonic drone and singing group include a continuous drone, the singing variable “la”, as well as pitch production on their instrument using the bow. Enrollment into one of two middle or two high school orchestra classes from two public schools in north Mississippi, as well as the skills necessary to use the bow for sound production and play

D, E, F-sharp and G, qualified participants for inclusion in the study. Students involved in this research provided demographic information to determine grade level and age. They also indicated the number of years of study on the instrument being used for the research.

Pretesting and posttesting consisted of performed pitches E, F-sharp and G on the participants' D-string. Pitch frequencies were analyzed and recorded. Tonic drone and tonic drone with singing groups consisted of one middle and one high school class each. Placement into either group was determined by a coin toss.

The tonic drone only group performed pitch-matching exercises without the singing variable. The tonic drone and singing group performed pitch-matching exercises using the syllable "la" along with a continuous drone. Both groups performed the exercises while hearing a metronome at 60 beats per minute. Three pitches, E, F-flat, and G, were addressed over a period of three weeks. At the conclusion of this treatment period, a posttest was administered to determine changes in participants' intonation accuracy. Pretest and posttest scores were compared to standard frequencies to identify changes in accuracy between and within groups.

Null Hypotheses

H_0#1: There will be no significant difference in pretest and posttest scores within either group (tonic drone, tonic drone and singing).

H_0#2: There will be no significant difference in pretest scores between groups (tonic drone, tonic drone and singing).

H_0#3: There will be no significant difference in posttest scores between groups (tonic drone, tonic drone and singing).

Research Questions

This study seeks to answer the following questions:

1. Can pitch-matching exercises employing a tonic drone improve intonation accuracy in string players?
2. Can pitch-matching exercises employing a tonic drone and singing improve intonation accuracy in string players?

Definition of Terms

1. Amusic: A condition marked by inability to comprehend music.

1. Audiation: The ability to hear and understand music when sound is not physically present.
2. Drone: A sustained pitch.
3. Orchestra: Music ensemble comprised of instruments from the violin family.
4. Pitch-matching exercises: Musical exercises employing the use of a drone as a reference for matching pitch.
5. Singing: The act of creating musical sounds with the voice.

Need for the Study

The use of pitch-matching exercises employing either a tonic drone or a tonic drone and singing for the purpose of improving instrumental intonation accuracy appears limited in the literature I have reviewed. Research that has investigated the relationship between pitch vocalization and instrumental pitch matching has been performed (Makos, 2011; Mattingly, 2012; Silvey et al., 2019; Makos). Mattingly (2011) and Silvey et al. (2019) asked undergraduate collegiate musicians to hear, sing, then produce a B♭ on their instrument following exposure to a single B-flat or a B-flat chord. They were then asked to vocalize the pitch before attempting to tune their instruments. No significant difference was found between the two procedures of tuning. Makos (2011) explored the relationship between beginning string players' vocal pitch accuracy and instrumental pitch accuracy. Treatment included vocal and instrumental pitch instruction over four weeks. Results showed a low correlation between vocal intonation accuracy and instrumental pitch accuracy. Frank (2006) found that singing pitch accuracy and playing pitch accuracy of fifth and sixth-grade violinists and violists had a positive relationship.

Instructors have shared their beliefs on the importance of vocalization in the orchestral classroom. Robinson (2006) advocated for the inclusion of singing at the beginning of band or orchestra rehearsals. The author emphasized the reasons many teachers fail to include this practice in their ensemble classes, among them: (a) instructor fear of singing in front of their class and (b) student loss of playing time on their primary instrument. A method of helping the musicians develop critical music making skills was introduced, helping them relate single pitches to the harmonic structure in which they are playing. The practice of singing their pitches along with the other parts in the band or orchestra will, according to the author, increase pitch accuracy.

CHAPTER II

REVIEW OF LITERATURE

The teaching of intonation to musicians is a frequently discussed topic. The literature I have reviewed includes concepts on teaching pitch improvement to singers, wind players, and string players. My review of research indicates a relatively small number of intonation-related studies concerning string players. In order to understand how pedagogic citations relate to the area of string music education, it is important that previous scholarly work on the topic of pitch perception and production be examined. Included in this review are studies related to pitch perception, aural skills training, drone use, vocalization, tone quality, technological stimuli, and teaching intonation in the orchestral classroom. The procedures and results of these studies and instructional methods are discussed.

Pitch Perception and Pitch Accuracy

Researchers have investigated the concept of pitch perception and its relationship to pitch production. Loui et al. (2015) compared individuals aged five through adult who were classified as “amusic” with a control group. Participants were exposed to pairs of small intervals presented as pure tones and asked to hum those pitches. They were also asked to indicate whether the second pitch was higher or lower than the first. Control subjects were able to correctly perform both aspects of the task, while those categorized as “amusic” had the most difficulty identifying pitch direction. Liu et al. (2016) asked 16 Cantonese-speaking individuals to perform directives relating to tone perception, production, and singing. In reference to the control group, those with amusia produced more pitch interval errors. Phillips and Aitchison (1997) performed a study that compared the relationship between singing pitch accuracy and pitch discrimination among third graders who were classified as either accurate or inaccurate singers. Students (*N*=79) from a small Midwestern school participated in the study. The authors/investigators evaluated the subjects' pitch singing accuracy by having them sing a song they had been taught in class. Accuracy was then rated by the authors/investigators, and singers were identified as "accurate" or "inaccurate" based on their score. Participants were then evaluated using the *Primary Measures of Music Audiation* test and Part 1, test 1 of the *Music Achievement Test* to determine levels of pitch discrimination skills. Singing accuracy and pitch discrimination ability were compared using a 2 x 2 multivariate analysis of variance (MANOVA). No significant difference was found between the groups concerning pitch discrimination and the ability to sing in tune.

In a study focusing on age and its relationship to pitch perception and vocal reproduction, Geringer (1983) examined 144 preschool (*n*=72) and fourth grade (*n*=72) students. Participants were pretested for pitch discrimination ability prior to testing for final analysis to determine placement into one of three groups (high, middle, low). For final testing, students sang the final pitch of a short prerecorded musical example. A strobocom tuner was used by a panel to determine pitch accuracy of the recorded samples. Participants' final scoring, based on the factors of age and ability group, was performed using a two-way ANOVA. A significant difference was found between the two groups, with the fourth graders being able to perform the task more accurately.

The tuning of an instrument's strings is a product of pitch perception and physical skill. Hopkins (2015) performed a study in which 46 middle school violinists were asked to determine whether a string was sharp or flat. They were then asked to adjust the string to the correct frequency. The instrument that was flat was tuned with greater accuracy than the sharpened pitch. Posedel et al. (2011) found a positive relationship between musical training and pitch perception. The researchers asked 45 participants whose native language was English to provide information concerning their musical training. Those with musical training were better able to perceive pitch. These studies suggest a positive relationship between musical training and pitch perception ability.

The use of tactile markers on stringed instruments has also been examined. Knotty (2018) researched the effects of using finger placement markers on the instruments of string students. The study lasted 13 weeks and included violinists and violists (N=14) from a beginner orchestra class. Participants were recorded playing a D-major tetrachord on their instruments. Tactile markers made of fishing line and scotch tape were then placed under the instruments' fingerboards at the intervals of a major second, a major third and a perfect fourth above the nut. Students were recorded playing the tetrachord on their instrument fitted with the tactile markers on Tuesdays and Thursdays, then on an instrument with no finger markers on Fridays. Posttests were recorded in wav file format using *Audacity* 2.1.2. Directional raw data scores of pre and posttests were converted to absolute values and compared. Although improvement to the pitch standard was found overall regarding intonation accuracy during the research, no significant differences were demonstrated.

Pitch Error Detection

The development of pitch error detection skills is vital in assisting accurate pitch reproduction either vocally or instrumentally. Holahan et al. (1994) performed an experiment using 24 college musicians, 24 college non-musicians, and 38 first graders to determine if musical training would have an influence on the speed and accuracy of pitch error detection. Subjects completed one of three 48-question tests designed to determine pitch discrimination aptitude. After hearing pitch samples for each question, participants were asked to indicate whether the samples were the same or different. Results showed that while response time differed between first graders and college non-musicians, pitch error detection between first graders and college musicians was not significantly different. A study by Sheldon (1998), also showed improvement following aural skills training. He examined the effects of sight singing and ear training on 30 undergraduate music education majors in an instrumental (methods and conducting) course. Fifteen of the musicians received additional weekly instruction on sight singing and ear training, while the remaining 15 did not. Testing performed at the end of the 11-week treatment period showed significant differences in pitch error detection between the two groups. The group exposed to additional training showed the most improvement in these skills.

Music Discrimination Skills

Researchers have explored the relationship of music instruction and musical discrimination abilities. Gromko and Russell (2002) examined the effect of active listening on the accuracy of reading a listening map. Forty-one second and third graders at a rural Iowa school took the *Intermediate Measures of Music Audiation* (IMMA) test and were systematically placed into one of three experimental settings: (a) passive listening (b) unstructured active listening and (c) structured active listening. The first group simply listened to musical examples. The second group was instructed to move their hand in sand to represent how they felt the music moved. The final group mirrored an instructor’s hand gestures while music was being played.

Following completion of the three treatments, participants were asked to follow an active listening map with either a pointer or their finger. Results showed no statistically significant difference in ability to follow the map among the three groups.

Gromko and Walters (1999) studied the relationship between audiation ability and musical pattern recognition. Elementary students (*N*=48) were administered the *Intermediate Measures of Music Audiation* (IMMA) to determine their audiation ability. Students were placed into one of four groups based on their test scores. The groups met weekly for four months during which they participated in an Orff orchestra. They also met with a second teacher who instructed them in sight singing. Results of the study revealed that the students with an initially high level of audiation ability showed greater improvement in musical pattern recognition accuracy than those who scored lower on initial audiation ability testing.

Posedel et al. (2011) examined the relationship between previous musical training and pitch perception, and their influence on phonological production of a second language. The researchers asked 45 participants to provide information concerning their musical training, as well as their experience with Spanish as a second language. Participants performed two tests: (a) *An Operation Span Test* which asked them to do a simple math problem associated with a word, then verbally recall that word and (b) a *Pitch Perception Test*, which asked them to determine if the second of two listening samples based on pitch, chords, or melody was higher, lower, or the same in pitch. Two Spanish professors assessed diction of the recalled words spoken for the first test using a Likert scale. While those with musical training were better able to perceive pitch and had better working memory, language pronunciation was only affected by pitch perception.

The influence of musical discrimination training incorporating models/discriminator foils and modeling/imitation was investigated by Delzell (1989). Beginning fifth-grade instrumentalists (*N*=43) were randomly placed into either a control or experimental group for 18 weeks. The experimental group was exposed to a tape-recorded discrimination training program that included (a) identification of discriminator foils employing a difference in one musical aspect (rhythm, melody, or tone) and (b) discrimination exercises in which the goal was to determine if the example was the same or different. The control group was not exposed. The experimental group had higher levels of discrimination skills concerning both rhythm and melody at the conclusion of the study.

Pembrook (1987) researched melodic discrimination ability using music theory students (*N*=153) placed into three groups. Group one heard a 7-note pattern, a 2-second pause, and a second 7-note pattern. They were then asked to indicate whether the second pattern was the same or different. The second group heard the patterns with a 19-second pause in between them. Group three sang the first pattern prior to hearing the second pattern. Groups one and two scored significantly higher than group three.

Vocalization and Pitch Matching

Researchers have also examined the relationship between previous vocal experience and pitch matching proficiency. Thirty-two subjects aged 15-32 participated in a study comparing relative pitch discrimination. Ngo et al. (2016) subjected musicians and non-musicians to the Montreal Battery of Evaluation of Amusia (MBEA) to assess pitch processing abilities. Musicians outperformed non-musicians on the task of discriminating different pitches.

Pitch-matching abilities of individuals based on various stimuli have been investigated. Demorest and Clements (2007) studied the pitch singing accuracy of adolescent males. Boys in grades 6-9 (*N*=60) who participated in the study were either involved in their school’s choir program or in a general music class. Students were asked to vocally match two recorded stimuli. The responses were recorded and analyzed in a similar method to that used in a previous study by Demorest (2001). Pitch was more accurate when a contextual condition was implemented. Matching a single pitch proved more difficult for these subjects. Green (1990) examined vocal modeling and its effect on pitch matching accuracy of schoolchildren. Two-hundred eighty-two students enrolled in grades one through six at a southern university laboratory school participated in the study. Audio tapes of singers performing descending minor thirds of G to E were used for testing. Subjects were exposed to three taped conditions: (a) female voice, (b) male voice, and (c) child voice. Once the student heard an example, they were asked to replicate it vocally. Recorded samples of each condition for each participant were then evaluated using a Korg Auto Chromatic Tuner, Model No. AT – 12. Responses based on the stimuli of the child voice were most accurate in pitch accuracy.

Tone Quality, Pitch Perception and Pitch Accuracy

Timbre is an influential element in pitch perception and pitch production. Geringer et al. (2015) exposed music majors from two large music schools to recordings of a musical excerpt performed on trumpet, violin, and voice. Frequency was altered in four sections to determine if the participants would perceive the pitch deviations similarly. The trumpet was perceived to be more out of tune where the pitch was lowered while the violin and trumpet were considered more out of tune when the pitch was raised. Worthy (2000) investigated the effect of tone quality variations on pitch perception and pitch production. Participants in this study included 32 high school band students from the southern United States and 32 college band students from a large southern state university. A comparison task was developed for measuring pitch perception in relation to tonal stimuli. In addition, a performance task was implemented to evaluate the correlation between the timbre of the stimulus tone and pitch matching. Instruments categorized as having “bright” tonal qualities were perceived as producing a sharper pitch. Participants reproduced pitches sharper following stimuli from “brighter” tones while performing them flatter following “darker” tones. Zabanal (2019) examined the effects of accompaniment from various instruments on the melodic context of stringed instruments. High school and college cellists, violinists, and violists (*N*=103) performed the melody to *Frere Jacques* while playing to a recorded accompaniment by a piano, an oboe, a cello, and a violin. They also played the melody with no accompaniment. Participants played most in tune with the oboe and least in tune with no accompaniment. Byo and Schlegel (2016) conducted a study to determine possible effects of tuning accuracy based on instruments’ relative timbre and pitch range. Instrumental groups categorized as bass, tenor, and soprano were used to create tone reference examples. The effect of an octave stimulus was investigated in relation to tuning. No measurable difference was found dependent upon the instruments’ tone color or relative register concerning pitch frequency.

Benson (2015) examined intonation responses to a recorded oboe playing A = 440 Hz with and without vibrato as well as pitches produced by a Korg™ tuner of A = 430 Hz, A = 435 Hz, and A = 445 Hz. Reactions to stimuli relating to vibrato, timbre, and frequency were examined. Subjects (*N*=198) were university, high school, and junior high school string, brass, and woodwind players. Student responses to stimuli were recorded and compared using MacRecorder™ software, then examined for absolute and directional cent deviation using a Korg™ Auto Chromatic Tuner. Concerning absolute pitch deviations, a three–way analysis of variance with repeated measures demonstrated significant differences in cent deviation to the tuning pitches among academic levels, with university musicians deviating the least and junior high students deviating the most from the standard. Brass players were found to be least accurate in tuning, while string players played most in tune. Examination of data using directional cent deviation found through chi–square analysis that musicians played flat overall. Subjects performed sharp to the Korg™ tuner, while playing flat to the oboe recording.

Technological Stimuli and Pitch Accuracy

Technological advances in electronics, digitization, audio and video have influenced researchers in investigating those technologies' relationships to musical concepts, including that of pitch accuracy. Anderson (1981) explored the use of tape-recorded models designed for individual practice among 80 sixth-grade students participating in mixed woodwind classes at two schools in Austin, TX. An experimental group was given a cassette tape containing musical examples addressing pitch reading, rhythm reading, tempo accuracy and intonation accuracy. A tuning pitch of B♭ was also provided on the cassette. The control group did not practice individual exercises using the tape-recorded models. Prior to beginning treatment, participants were evaluated on tempo accuracy, pitch-reading, intonation, and rhythm-reading through administration of the Watkins-Farnum Performance Scale (Form B). Following the eight-week treatment period, intonation was measured using a Stroboconn Chromatic Tuner. For each pitch, two samples were selected from participants' performance of a sight-reading excerpt. The deviation in cents for the two sample pitches in relation to equal temperament was averaged. Deviation in cents for four chosen pitch samples determined pitch accuracy. No statistical difference between the control and experimental groups was found concerning pitch accuracy at the conclusion of the study.

Nunez (2002) studied the effects of audio and audio/visual influences on the intonation of string players. The research employed a pretest/posttest design using three playing examples comprised of seven notes each. Eighty-two seventh-grade violinists and violists participated in the study which lasted 21 class sessions, directed by the students' teachers. Subjects were exposed to (a) an audio treatment in which the teacher demonstrated intervals on the instrument followed by student replication of the task and (b) the same audio treatment in addition to a visual component consisting of an image of the instrument with marked representation of where the fingers were to be placed on the fingerboard. Following the treatment period, pitch deviations in relation to equal temperament were measured in cents. Pretest and posttest samples were compared for changes in pitch accuracy. No statistically significant difference was found between the two treatments.

Paney and Kay (2015) examined the influence of concurrent feedback on pitch-matching skill development among third graders. The researchers gathered data from a 2012 project named *The Great American Singing Challenge* (GASC), in which singers received concurrent feedback on pitch accuracy while singing "America". The computer program *SingingCoach*, which provides a visual representation of pitch accuracy to the user in real time, was used for practice/concurrent feedback and scoring. Pretest and posttests scores of 2,021 third graders were examined. Analysis of the data showed a significant improvement in scoring at the end of the study concerning use of visual formatting which included both a staff and graphic formatting. Third graders who practiced one to five times a week showed significant improvement in pitch matching ability over the course of the study, while those who practiced less than five times per week did not. Similarly, Paney and Tharp (2019) employed a treatment-control approach, as well as the computer program *SingingCoach*, to investigate the effects of concurrent feedback. Pitch accuracy was measured. College students (*N*=44) enrolled in music appreciation courses volunteered to participate in the study. Ten of these volunteers were ultimately removed from participation due to lack of participation. The remaining 34 participants were placed into a control group or experimental group. Subjects placed into the experimental group were able to see the accuracy of their pitches while singing musical examples, allowing them the ability to alter their pitches in real time. The control group placed a cover over the computer screen while performing the tasks, therefore receiving no concurrent visual feedback on pitch accuracy. Participants met weekly for 10 weeks and data was collected for eight songs using the easy level of the software. Based on pretest and posttest analysis, general improvement in pitch accuracy was seen. Although the experimental group did show scoring improvement greater than that of the control group following completion of the treatment period, no statistically significant difference was found.

Addressing Intonation in the Orchestral Classroom

Many pedagogues have presented varying concepts relating to improving pitch accuracy among instrumentalists in large group instructional settings. Yu (2011) compared Shin'ichi Suzuki's *Suzuki Violin School, Volume 1* to Kurt Sassmannshaus's *Early Start on the Violin, Volumes 1 and 2*. Both teaching manuals included the use of familiar folk tunes for the students in aiding them in developing pitch and rhythmic progress. However, Sassmannhaus had students reading notes at the start of instruction, while Suzuki preferred students begin training by rote. Suzuki related the learning of music to learning a language, emphasizing playing by ear before learning to associate pitches with symbols.

Researchers have attempted to determine the amount of emphasis that instructors place on pitch accuracy in the orchestral classroom. Schulte (2004) surveyed 20 first year string classroom instructors to determine necessary skills for a successful beginning year of string music instruction. Ninety-five percent of these experienced teachers agreed that ear training should be included in the classroom during the first year of instruction. Respondents to the survey were unable to meet a consensus in defining ear training, many describing it as "call- and-response" kinds of activities, pitch-matching, and listening and responding" (p. 130). Colwell and Hewitt (2011) also advocated addressing intonation with beginning string students. The authors advocated focusing attention on pitch accuracy early with groups of beginners. Bowing of pure fifths on adjacent strings, as well as learning scales in D, G and A major, were viewed as tools to help the new string player focus on playing in tune. Solid, relaxed posture of the left hand was noted as an aid in increasing pitch accuracy. Students were encouraged to develop the tuning of their instruments' open strings soon after teacher demonstration of the process to help develop independence in tuning ability. They suggested teachers be patient when helping the musicians listen for the "beats" when playing the double stops, giving input as they altered pitches to remove those "beats".

Many orchestral instructors have condoned an audiation-based approach to help improve intonation in the string music classroom. Schleuter (1997) described the capacity to produce desirable intonation as being related to tonal audiation ability. The author emphasized the hearing and singing of melodies prior to attempting to perform them on an instrument, claiming increased pitch accuracy over not including these practices. Focus on pitch-correction techniques during the initial month of their learning was encouraged, correcting errors as needed. Following early emphasis on intonation, the musician would be allowed to self-correct as much as possible to encourage independent tuning skills. Clauhs (2018) emphasized developing a student's ability to “hear” a pitch before singing it. Once the student had shown competency in this task, musical elements such as note reading and an introduction to the instruments of the ensemble would be enacted in a deliberate, systematic manner. Instrumental skills would be phased in while audiation practice continued. Hiatt and Cross (2006) addressed the use of audiation in both private and classroom string music instruction. Their method employed an aural and oral hierarchy frequently absent in string music classrooms. Students were initially asked to sing the pitch about to be played, then focus mentally on that pitch. Finally, the musician would be asked to compare the played note with the mental note. The goal was to eliminate, over time, the need for the teacher to point out poor intonation.

Several writers have based their audiation-based teaching approach largely on Gordon’s music learning theory. Dalby (1999) suggested the use of an audiation-based approach in instrumental classroom instruction, emphasizing the importance of singing before playing and how that action improves intonation. In addition, the use of tonal support, through key-related harmony, was recommended to give individual pitches tonal reference. Employing tunes familiar to the students, allowing them to step away from the confines of note reading, was another useful tool the writer suggested integrating into the classroom. Conway (2003) encouraged teachers to be sure their beginning musicians were hearing a pitch before having them attempt to replicate that pitch on their instruments. Essentially, she advocated singing before playing. The reason this was stressed, according to the author, was due to the propensity of the technical aspects of playing an instrument to quickly dominate the focus of the learner, de-emphasizing that learner’s concentration on intonation.

Additional research has explored the relationship between increased ensemble instruction and intonation accuracy. Stabley (2000) conducted a study of three orchestra classes at a middle school of sixth and seventh graders. The students were instructed in orchestra only or orchestra with the addition of chamber music instruction. The treatment condition of chamber music instituted outside of regular orchestra class received little teacher intervention. Results of the study showed a significant difference in intonation test scores between the two groups. Additional data showed a correlation between the addition of chamber music and a more positive attitude toward orchestra, possibly influencing intonation scores.

Studies have produced mixed results concerning focus on intonation accuracy improvement in the band and orchestra classroom. Hewitt (2001) conducted a study to determine what effect that modeling, self-evaluation, and self-listening might have on junior high instrumentalists. When participants used a model while practicing musical skills, there was an improvement in ratings of tone, melodic accuracy, rhythmic accuracy, interpretation, and overall performance. Intonation showed no improvement when these techniques were applied to students' practice routines. Mora (2007) also explored addressing intonation accuracy in the classroom. Two sixth-grade band and two sixth-grade orchestra classes were placed into control and experimental groups. One band and one orchestra class each received daily instruction of pitch pattern imitation, consisting of no more than eight notes each lesson chosen randomly by each teacher. They also had regular class instruction. The control groups, one each of band and orchestra, did not receive the tonal pattern training. Independent *t*-tests were performed. Results showed a significant improvement in pitch accuracy in the experimental band group following the 11-week study, while the experimental orchestra group scored higher than the control orchestra group. The research suggested tonal pattern training can increase instrumentalists' pitch accuracy.

Temperament and its Use in Addressing Intonation

The topic of temperament is of great importance when discussing intonation. Stauffer (1998) discussed this issue as it related to private as well as classroom instruction. The importance of including the proper system was emphasized for good individual and group intonation accuracy. The author attributed his preference for equal temperament over both just and meantone tuning to "over two centuries by trial-and-error recognition of great musical minds and talents, to clarify and laud a musical scale that has maintained nearly universal acceptance in the western world since 1850" (p. 62). Two main reasons cited for using this system over others in ensemble and private instruction are its ease of use across all 12 possible keys and our inherent preference for it due to early exposure to mean tempered instruments such as the piano and organ.

Drone Use and its Relationship to Intonation

The use of drones for intonation improvement has been addressed by several researchers. Laux (2015) examined the influence a drone pitch might have on the intonation skills of beginning string players. Participants (*N*=50) from three middle schools were pre and posttested by having them perform one-octave C and D major scales. Performances were recorded and analyzed using Intonia software. The middle one second of each sample was used for frequency analysis. Deviations for each recorded pitch (equal temperament) were documented in cents difference in relation to the standard. Each of the three participating classes were randomly assigned to one of three groups. Each group played C and D-major scales while hearing either (a) a drone/tonic pitch, where the students played scales while being accompanied by a drone only (b) pitches of the scales, where they played scales without a drone sounding, but were accompanied by the pitches of the scale they were performing (c) a drone with pitch matching, where they played the scales with both drone and scale accompaniment. No significant improvement in pitch accuracy concerning any of the three treatment conditions was found at the completion of the study.

Researchers have explored the use of tonic drones and their effects on the intonation accuracy of wind players. Springer et al. (2020) asked college clarinetists and trumpet players (*N*=68) to play a four-measure excerpt from the song "Long, Long Ago" under three conditions. For the first condition, the excerpt was played with tonic drone accompaniment. In the second condition, the musicians played the song with both tonic and dominant drone accompaniment. For each of the first two conditions, the participants heard the drone pitch(es) prior to and during their performance of the excerpt. The third condition served as a control and had no accompaniment. Recordings were made of each of the three conditions and compared for their effects on intonation accuracy. A repeated measures MANOVA indicated no significant difference in pitch accuracy in relation to condition type.

Zabanal (2019) studied the use of drones for brief periods and their effect on intonation accuracy. Middle and high school violinists and violists (*N*=28) were recorded aurally while playing an ascending stepwise pattern starting on their instruments' D–strings and continuing to the A-string, as well as a descending 7^{th} arpeggio beginning on D and ending on E. The participants were then given one minute to practice the excerpts while accompanied by a drone pitch. A second recording was made using the same pitch patterns present in the first recording under two conditions (a) with drone accompaniment and (b) without drone accompaniment. Pitch frequencies were then converted to cent deviation in relation to equal temperament. Pretest and posttest differences were compared. No significant difference was found in pitch accuracy concerning pretest, drone accompaniment, and no drone accompaniment.

Drone Use in Pedagogical Literature

Several pedagogues have discussed the use of drones in the instrumental classroom. Griswold (1988) advocated the use of drones produced by tuners to help improve aural skills. He first had students perform memorized scales while the tuner produced a tonic drone, claiming that having them memorized allowed increased focus on their listening skills. In early applications of this step, he emphasized careful guidance by the instructor, aiding the musicians with technical adjustments employing embouchure and air flow. As they became more comfortable with the process, teacher intervention would become less frequent. The second step asked the instructor to have the tuner produce a drone pitch other than the tonic, claiming this procedure aided in even further focus on intonation. For a classroom setting, the author suggests having a drone, such as the tuning note B♭, playing as the students enter the room. They would then softly tune to that pitch and perform scales to it as it played continuously. These practices were intended to help introduce the musicians to the practice of practicing with drones.

Harnum (2013) considered the use of electronic tuners inferior to pitch-matching using drones. He felt the visual aspect of staring into an electronic device while adjusting pitch detrimental, stating "With a tuner, the eyes are engaged, but the ears just sit there slack-jawed. A tuner isn't helpful to a person who needs to engage their *hearing"* (p. 52). He advocated for the inclusion of a drone as the primary tool for improving intonation, particularly among singers and instrumental musicians performing on bowed or wind instruments. The author chose drones produced by the tanpura, a four-or five-stringed plucked instrument tuned in unisons or octaves as the preferred tool for this ear-training practice, feeling that the overtones it created were a great asset. He described several methods for drone practice, ranging from the simplest of unison tuning, called long tones, to the more complex, including playing a memorized melody with a drone as well as improvising with a drone. The purpose of eliminating the tuner in favor of the drone was to emphasize the act of *hearing* for improved pitch performance.

Reel (2005) references cellist Marcia Sloane who stated, “playing with a drone develops an awareness of frequency relationships, an awareness that can carry over into listening and tuning in all playing situations” (p. 26). She suggested string players initially use their fine tuners to tune to a drone that is either recorded or being produced by a partner on another instrument, intentionally tuning above and below the sustained pitch until finally matching it. Next, the musician would match the drone with an octave, fifth, then the third of the scale. Progressively, the drone should be added to passage work as a tuning reference. Similarly, Zabanal (2020) developed a process of using drones to help improve the intonation skills of musicians in private as well as classroom settings. He suggested students first master tuning the open strings to a sustained pitch, gradually adding unisons and octaves, initially against adjacent open strings, then reproduced drones. Major and minor thirds, seconds, and sevenths should then be addressed in a similar manner.

Effects of Vocalization on Instrumental Pitch Matching

Numerous researchers have investigated the relationship between pitch-vocalization and pitch-matching. Mattingly (2012) examined the effect that hearing and singing a tuning note had on 33 middle-school flute players’ pitch-matching accuracy. Participants from a middle-school in the southeastern United States had one to four years of playing their instruments. Students were first exposed to a pre-recorded B-flat chord as well as a single B-flat. They were asked to tune a flute to the B-flat. The flute was then reset into its original position, and they were asked to sing the B-flat after hearing the pre-recording, then tune the flute to the B-flat again. Intonation accuracy was measured using a computer program that had been measured prior to the experiment to be in agreement with recorded stimuli. The difference in cents from the standard provided by the stimuli was determined. No significant difference was found between the two procedures of tuning. Similarly, Bennett (1994) investigated the effects of an instructional period including vocalization on the tuning procedures of wind players. Edwin Gordon's (1991) *The Advanced Measures of Music Audiation* assessment was administered to 96 junior high and high school students. The researcher used a single–group pretest/posttest design for the study, meaning it contained no control group. The pretest consisted of the participants playing a series of nine pitches for 10 seconds each. These pitches were recorded. Between pretesting and posttesting, the musicians received four instructional sessions of around 30 minutes each. These sessions were designed to help familiarize them with the posttesting procedure. Following this instructional period, the participants were given a posttest that added the element of humming the pitches before playing them. Pitch frequencies derived from pretest and posttest recordings were converted to cents and compared for intonation accuracy. No significant differences were found in pitch accuracy between the samples, with the pretest scores being more accurate than the posttest scores.

The effect of consistent vocalization practice in instrumental group settings has been researched. Elliott (1974) evaluated students participating in six beginning band classes from six public schools for pitch discrimination and tonal memory. Control and experimental groups each consisted of three of these classes and used the same method book for instruction. The classes met daily for the entire school year. The participants in the control group only performed the exercises on their instruments, while those in the experimental group both sang and played the same exercises on the syllable "la". Posttesting performed at the end of the school year showed a significant difference between groups, with the experimental group performing better in both pitch discrimination and tonal memory abilities. The experimental group also showed significantly greater ability to identify accurate pitches at the end of the study. Similarly, Schlacks (1981) investigated singing and its effect on the pitch accuracy of high school band students. Band members (*N*=136) from four high schools in Fort Wayne, IN. were administered the *Music Achievement Test-Test 3 "Pitch Recognition"*, designed by Richard Colwell (1970). The *Watkins-Farnum Performance Scale*, an Interval Performance Test designed by the author, as well as an author-designed questionnaire, were also administered. Participants in each school band were placed into one of three experimental groups and received one month of interval training. Each of these groups performed one of the following protocols during the treatment phase: (a) vocalization and instrumental playing of intervals (b) vocalization of intervals or (c) instrumental playing of intervals. Those in the fourth band were part of the control group that maintained their normal rehearsal schedule. Following the month-long treatment phase, posttests were given using the same measurements present in pretesting. Data obtained through comparison of pretesting and posttesting was submitted to analysis of variance of gain or difference scores from pretest to posttest including the Scheffe test for differences of means. Results showed that the combination of singing and playing intervals on the instruments had a greater impact on pitch accuracy than either singing or playing intervals only.

Scherber (2014) examined the effects of vocalization exercises on intonation accuracy in band classrooms. Students (*N*=47) from four middle and high schools were given identical pre-and posttests designed by the investigator to rate their abilities in pitch perception, tuning their instrument, and performing a melody. The control and experimental groups were each comprised of one middle and one high school. Over the six-week treatment period, students in the experimental group were subjected to several instructional techniques including beat elimination, interval training, tuning procedures and vocalization, while the control group was not. Vocalization exercises in the classroom were included in a five-minute warmup period performed after group tuning of instruments, typically consisting of vocalizing classroom musical exercises on "la" or using scalar numbers. Recorded samples of students tuning their instruments to pre-recorded pitch samples were made, as well as recordings of them playing a melody on their instrument. Posttest recorded samples were compared using repeated measures (ANOVA) tests. No significant difference in intonation accuracy was found for either task.

Silvey et al. (2019) explored pre-tuning vocalization activities and their relationship to tuning accuracy. Seventy-two undergraduate college wind players were asked to match a prerecorded tuning pitch (B-flat) that had been produced on an oboe using no vibrato. Subjects first heard the stimulus pitch. Three pitch-matching variables were then performed by participants prior to playing the stimulus pitch on their instrument: (a) singing "la", (b) humming the pitch, and (c) silence. The instrumentalists were asked to match the tuning pitch following each of these conditions. A control of silence between hearing and instrumental pitch-matching was also implemented in the study. The middle three seconds of recorded samples were analyzed using Pratt software. Conversion from Hertz to cents was performed using an online calculator. Cent deviations were then compared with the stimulus pitch for pitch accuracy. Data showed no statistically significant difference among the three conditions. Singing "la" produced the greatest pitch accuracy in 29 of the students, a larger number than either humming or silence.

Studies have been performed in relation to the efficacy of vocalization and playing in tune on stringed instruments. Hopkins (2006) examined playing intonation in beginning violinists and violists and its relationship to singing intonation. Thirty-one fifth and sixth-grade students were placed into one experimental group. The subjects first sang *Row, Row, Row Your Boat* to help establish reliability in the ratings process. *Yankee Doodle* was then performed by each student, first vocally, then on either the violin or viola. Ratings of the musical example were performed by string and vocal judges using a Likert scale. Results of the study indicated a correlation between singing pitch accuracy and instrumental pitch accuracy.

The relationship between vocal pitch accuracy and instrumental pitch accuracy has been studied. Makos (2011) explored the relationship between beginning string players vocal pitch accuracy and instrumental pitch accuracy. Twenty-eight sixth graders from two schools were included in the study. The students from three different classes were taught an eight-measure etude over a four-week period. Instruction was given vocally as well as instrumentally. Vocal and instrumental recordings of the subjects performing the etude were made after the four -week treatment period. A five-point continuous scale was used by two independent judges to rate intonation accuracy. Results showed a low relationship between vocal intonation accuracy and instrumental pitch accuracy. In a related study, Smith (2005) examined the effects of an aural/oral training program on string players' pitch discrimination ability as well as how any improvements in pitch discrimination skills from those exercises might relate to pitch performance accuracy. The sixteen-week study was conducted in two public schools in the Seattle, WA, area. String students (N=96) were randomly placed into an experimental or control group. Those in the experimental group left class for 20 minutes two days a week to perform the researcher designed exercises. The students in the control group stayed in their regular classroom and continued with their normal lessons. Pretesting and posttesting was identical and used tape-recorded samples of the participants playing on their instruments to rate pitch accuracy. Aural pitch discrimination was measured using the pitch subtest of the *Colwell Music Achievement Test.* The treatment phase of the study employed researcher-designed singing and playing exercises in conjunction with the TAP Pitch Master machine. This machine is capable of giving real time aural feedback to the user. Each treatment session contained 15 exercises, which consisted of combinations of tonic, subdominant, or dominant degrees of C, G, and D-major. The students first heard the exercises, one at a time, then sang them into a microphone. The machine gave feedback of accuracy or inaccuracy of pitch. The student could not move forward until singing accuracy was achieved. Once singing accuracy was gained, the student heard, then performed the exercise on their instrument. Three judges were employed to rate playing examples for pitch accuracy. One-way analyses between groups showed the experimental group demonstrated significant gains in both pitch discrimination skills and instrumental performance pitch accuracy at the end of the study.

Results of studies investigating the effects on intonation accuracy of singing a pitch before playing it have been mixed. Research has shown that the act of singing then playing pitches can produce positive results (Elliot, 1974; Schlacks, 1981). Still others have found no significant positive intonation improvement between singing and playing (Bennet, 1994; Mattingly, 2012; Scherber; 2014; Silvey et al., 2019). Some investigators found a positive correlation between singing pitch accuracy and playing pitch accuracy (Hopkins, 2006; Smith, 2005), while Makos (2011) did not.

Summary

According to the literature reviewed, pitch perception ability as it relates to musical training has a positive effect on intonation accuracy (Posedel et al., 2011; Gromko and Walters, 1999). Instrumentalists play better in tune when tuning to an oboe (Byo and Schlegel, 2016).

Studies show mixed results concerning the relationship of instrumental accuracy to singing accuracy (Frank, 2006; Makos, 2011). Increased pitch accuracy was associated with singing more than humming (Silvey et al., 2019). Some music educators advocate singing at the beginning of ensemble rehearsals, associating the practice with improvement in pitch accuracy (Robinson, 2006).

The literature appears limited in its presentation of studies involving string players' pitch accuracy when first hearing a pitch, then playing it on the instrument, as well as hearing a pitch then singing that pitch before playing it on the instrument. This study aims to examine the effects of two conditions (1) hearing a sustained tonic drone, then pitch-matching that sustained tonic drone on the instrument (2) hearing a sustained tonic drone, singing the sustained tonic drone, then playing the sustained tonic drone on the instrument.

CHAPTER III

METHOD

The present study investigated the effects on pitch accuracy of middle and high school string players when exposed to either (1) hearing a tonic drone then matching the tonic drone pitch on their instrument and (2) hearing a tonic drone, singing the tonic drone, then playing the tonic drone on their instrument. The researcher selected two school districts in proximity to each other and with established middle and high school string orchestra programs to perform the investigation. Input from committee members also aided in the selection process due to class sizes, history of the string programs at those institutions, and congruent grade classifications of the students. The two public school string programs involved in the study were the only ones that were currently active in the region, which also factored in the decision of choosing which programs to study.

At the time of research for the study, one of the two middle schools had an enrollment of 1,007 sixth and seventh grade students. Fifty-one percent of these were African American, 37% White, 7% Hispanic, 2% Asian, and 3% two or more races. Sixty percent of students qualified for free or discounted lunch. The second middle school had an enrollment of 705 and an ethnic makeup of 50% White, 37% African American, 7% Hispanic, 2% Asian, and two or more races 4%. Forty-five percent of these students qualified for free or discounted lunch. Of the two high schools included in the research, one had an enrollment of 1,937 students and an ethnic makeup of 48% African American, 39% White, 7% Latin, 4% two or more races, and 2% Asian. Forty-two percent of these students qualified for free or discounted lunch. The second high school had a racial makeup of 57% White, 31% Black, 5% Hispanic, 3% two or more races, and 3% Asian. Free or reduced lunch eligible students comprised 39% of the student population.

Consent and Approval of Research

I was the principal investigator of this study. Permission to perform this study, "The Effects of Tonic Drone and Singing Exercises on the Intonation Accuracy of Middle and High School String Players," was obtained through appropriate administrators from participating school districts and through the Institutional Review Board (IRB) at the University of Mississippi. IRB certification for the study was approved as Exempt under 45 CFR 46.101 (b) (#1). Approval to perform research was requested and received from the acting principal of each school. In keeping with IRB requirements, an informed consent form was submitted for approval. To meet the IRB requirement of voluntary participation in the research, a recruitment letter was distributed to potential study participants to be delivered to their parents/guardians. The recruitment letter, parental consent, child assent, and information forms can be found in Appendix C. Once approved, participants were issued a consent form by their orchestra instructor. The students then returned the completed forms to the same instructor, which were then collected by me. Anonymity and confidentiality were provided by ensuring that "(a) the recorded data will not associate a subject with his/her data, and (b) the data will not identify a subject." The data was kept in a locked filing cabinet to which only the investigator had access.

Participants

Subjects for this study were middle and high school students enrolled in two north Mississippi orchestra programs. One middle school and one high school class from each of these programs were included in the study. The middle schools in each of these school districts consisted of grades seven and eight, while the high schools included grades nine through twelve. Subjects met the minimum criteria for participation: (1) a minimum of one year experience on the instrument, (2) demonstrated ability to hold the instrument properly, (3) competency using the bow to produce a clear tone, and (4) the ability to play E, F-sharp, and G on the D-string of their instrument. Competency with these skills was determined by their orchestra directors. The pitches E, F-sharp, and G were chosen due to their propensity to be among the first four pitches introduced in string method books (Allen et al., 2004; Isaac, 1965; Shade & Woolstenhulme, 2016).

Tonic drone and tonic drone and singing groups each consisted of one middle school class and one high school class. Placement into either the tonic drone group or the tonic drone and singing group was determined by a coin toss. A total of four classes participated in the study (two middle school and two high school).

Signed consent forms were returned by 88 students. A total of 58 of these musicians qualified for inclusion in the research by participating in both the pretest and posttest as well as being present for all treatment sessions. Instrumental distribution was as follows: violin (n=38), viola (n=1) cello (n=14), and bass (n=5). Two orchestra teachers, one per school district, facilitated implementation of in-class treatments. One of these instructors had taught two years at their current position, while the second teacher had taught nine years in that position.

Both tonic drone and tonic drone and singing groups participated in their respective treatment sessions at the beginning of regularly scheduled orchestra class. These classes met during normal school hours. Classes had a heterogeneous design that included instruments from the violin family (violin, viola, cello) as well as the contrabass. Instrumental makeup varied by class. To avoid disrupting the flow of the instructional atmosphere, all students in the orchestras had the option of participating in the quasi-experimental study. Instructions for the teachers who administered the exercises can be found in Appendix A. Orchestra classes occurred three times per week. As a result of this meeting schedule, treatments also occurred three times per week.

Pretesting and Posttesting

I administered all audio testing. Pretesting and posttesting of all participants was performed in a room adjacent to the orchestra classroom. All safety protocols related to the COVID-19 pandemic required by participating schools were strictly adhered to by the investigator.

Pretesting and posttesting was identical. Each student who had been approved for the study was individually pulled from their orchestra classroom to an adjacent room for testing. Prior to pretesting and posttesting, I led each of the classes through the testing process as a group. Students were asked to bring their bow and instrument into the pretesting room following normal tuning and warmup procedures with their instructor. I read the following instructions to each class group prior to testing:

> You have been selected to participate in a research project for the University of Mississippi. Thank you for your participation. You will be asked to perform a series of tasks during the implementation of this project. Feel free to ask questions prior to testing.

Tasks:

1. Researcher will help tune your instrument's D-string if needed, then place a pickup on your instrument.

2. You will be allowed one minute to play/warmup on your instrument if you desire.

3**.** Using the bow, on the D-string, play the pitches E, F-sharp, and G for a total of 4 counts each.

4. Before you play each pitch, you will hear a metronome for a total of four counts, quarter-note equals sixty beats per minute. The metronome will continue throughout the procedure. Once you have played a pitch for four counts, wait for four counts, then play the new pitch for 4 counts. Keep in mind that your playing data/information will be anonymous. In other words, no one is ever going to know how well you played. The testing will occur as follows, four counts per section:

[Metronome 4 beats/Play E 4 beats] [Metronome 4 beats/Play F-sharp 4 beats]

[Metronome 4 beats/Play G 4 beats]

Once each participant had completed the pretest, they were returned to their classroom and a new student was pulled to be tested in the same manner as previously discussed.

Procedure

Recorded exercises designed for use by the instructors during implementation of classroom exercises related to the study were created by the investigator using a metronome, the PC laptop and the program 'Online Tone Generator', which produces pure tones. Sound equipment used by the instructors for the treatments was subject to that available in each classroom. A continuous drone was not present during pretesting and posttesting. The objective of the current study was to assess changes in pitch accuracy as a result of pitch-matching exercises, not the skill of pitch-matching.

The treatment exercises were prerecorded to aid in consistency and ease of application for the instructors. Garageband, a multi-track recording app, was used to prepare the stimulus recordings. These recordings were provided to the instructors on a weekly basis, one for each pitch, and began with verbal instructions describing the exercises prior to each treatment. The treatments for both groups, tonic drone; tonic drone and singing, included a continuous drone and an audible pulse produced by a metronome at 60 bpm. Care was taken to balance the volume of the metronome. The drone pitches consisted of pure tones of E4, F-sharp 4 and G4.

Treatment procedures were based on those done by Laux (2015). The tonic drone group heard then played the drone pitch, while the tonic drone and singing group heard the drone pitch, sang “la”, then played the drone pitch. The treatments were employed over a period of three weeks and applied at the beginning of each class meeting. A new pitch was added each week so that all three pitches of, E, F-sharp and G were addressed over the course of those three weeks. Each exercise was repeated three times for a total of four presentations per session. A description of treatment procedures can be seen in Table 1.

Table 1

Exercise procedures for tonic drone/tonic drone and singing groups

Week	1	2	3
Pitches	E	E, F-sharp	E, F-sharp, G
Tonic Drone	Listen/play	Listen/play	Listen/play
Tonic Drone/Singing	Listen/sing/play	Listen/sing/play	Listen/sing/play

Data Collection

A Korg™ CA chromatic tuner was used to help tune each subjects' D-string prior to pretesting and posttesting. An Imelod MD-20 transducer microphone pickup was attached to participants' instruments, then connected to the laptop to aid in recording efficiency. This helped reduce ambient noise in the data collection environment. Pratt (Boersma & Weenink, 2013), a computer software program created to record and analyze sound, was used to record pretest and posttest pitch samples on an ACER Aspire E 15 laptop. Praat was then used to obtain pitch frequency averages of the recorded samples (Boersma, 1993; Hopkins, 2015). The samples (approximately four seconds long each) were reduced in length to include approximately the middle two seconds of those samples (Boersma & Weenink, 2013). This eliminated the initial attack at the beginning of the sample as well as the decay at the end of the sample.

Data Analysis

Reliability was obtained by having a trained research assistant perform the same analysis of 20% of pretest and posttest scores as the investigator. The reliability was .94

(agreements/agreements plus disagreements). An agreement was reached when both analyzed samples were within ± five cents of the pitch standard (Mattingly, 2012). Data consisted of participants' pretest and posttest pitch frequencies. The dependent variable was pitch accuracy measured in Hz and converted to cent. The open D-string was not included in the final data as it did not allow the participants the ability to manipulate the pitch with the left hand.

Data analysis was performed based on procedures performed by Hopkins (2015). Participants' pretest and posttest pitch frequencies were compared to the frequency of the model. To accommodate the differences in octave ranges among the various instruments' open D-strings, pretest and posttest samples were compared to those instruments' corresponding octave range standards in equal temperament. Accuracy was calculated by comparing the cent difference between the subjects' responses and the relative reference tone. Conversion to cents was performed using a hertz to cents calculator. The compared distance of these scores in relation to the frequency standard were then measured for improvement or regression as they related to the model pitch. A Split-plot ANOVA (SPANOVA) was performed to determine levels of statistical significance in pitch accuracy between the two groups from pretest to posttest. Correlated t-tests were performed to determine levels of statistical significance between groups from pretest to posttest. Independent t-tests were performed to determine levels of statistical significance within groups from pretest to posttest.

CHAPTER IV

RESULTS

The purpose of the present study was to investigate the effects of pitch-matching exercises on two groups: (1) tonic drone only and (2) tonic drone and singing, on the pitch accuracy of middle and high school string players. The null hypotheses stated: 1. There will be no significant difference in pretest and posttest scores within either group (tonic drone or tonic drone and singing) 2. There will be no significant difference in pretest and posttest scores between either group (tonic drone or tonic drone and singing) 3. There will be no significant difference in pretest scores between either group (tonic drone or tonic drone and singing) and 4. There will be no significant difference in posttest scores between either group (tonic drone or tonic drone and singing).

Fifty-eight students were recruited and agreed to participate in the study. Pretesting was conducted to determine pitch accuracy in relation to three pitches, E, F-sharp, and G on their instruments' D-strings. Students were then randomly assigned to two groups. Group 1 performed exercises that included the tonic drone three times per week. In Group 2, participants performed exercises that included a tonic drone and singing three times per week. Subjects engaged in these pitch-matching exercises for three weeks. Posttests were conducted at the end of the three weeks to determine intonation change in relation to the initial pitch standards. I assessed intonation by examining the middle two seconds of each audio recorded pre and posttest pitch sample. The collected data was converted from Hz to cents using a Hz to cents calculator, then transformed by adding 100 to each measurement so that sharp and flat were retained in the dependent measure. This transformation was performed to facilitate the elimination of negative numbers in relation to sharpness and flatness of pitch as these were not concerns of the current study.

Main Effect

T-tests were performed to determine significance of difference in intonation accuracy across testing periods between tonic drone and tonic drone and singing groups. An alpha level of .05 was utilized. Correlated samples t-tests found no significance of difference in pretest (*M*=95.06, *SD*=19.46) and posttest (*M*=95.06, *SD*=19.17) scores within the control group. Correlated samples t-tests found no significance of difference in pretest (*M*=101.17, *SD*=80.05) and posttest (*M*=88.86, *SD*=20.99) scores within the experimental group. Independent samples t-tests showed a significant difference between groups in posttest scoring (p=.005), with the tonic drone group (*M*=97.73, *SD*=19.17) being more accurate than the tonic drone and singing group (*M*=88.6, *SD*=20.99), thus rejecting the null hypothesis.

Individual Pitch Results

A split-plot analysis of variance (SPANOVA) was conducted for each pitch addressed between tonic drone and tonic drone and singing groups across pretest and posttest measures of intonation accuracy. An alpha level of .05 was utilized. Assumptions for normality, homogeneity of covariances and homogeneity of variances were met. There was no significant interaction for pitch (E4) and quasi-experimental conditions (tonic drone/tonic drone and singing), $F(1, 56) = .412$, $p = .523$. The tonic drone and singing group had slightly greater improvement in intonation accuracy as indicated in Table 2. Intonation accuracy improved in both groups upon engagement of an intonation routine (see Figure 1).

Table 2

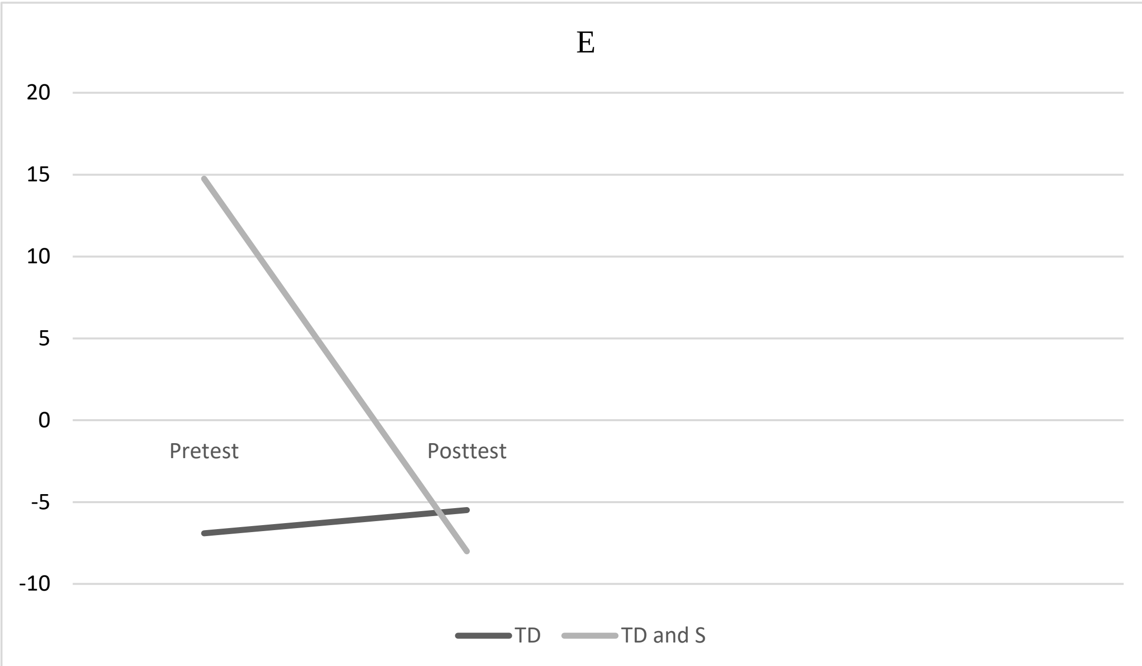
Pitch Accuracy Mean and Standard Deviation in Cents

	E Pretest			E Posttest		
	$\bar{X}$	SD	N	$\bar{X}$	SD	N
TD	-6.91	24.2	22	-5.49	19.03	22
TD and S	14.75	134.9	36	-8.01	15.87	36

Note. Numerical indicators are in relation to cent deviation from 0, which represents the pitch standard.

Figure 1

Pretest and Posttest Means in Cents for E



In relation to the pitch F-sharp 4, there was not a statistically significant interaction between pitch and quasi-experimental condition, $F(1, 56) = .412$, p = .102. The tonic drone group demonstrated an increase in intonation accuracy from pretest to posttest as indicated in Table 3. The tonic drone and singing group did not show greater intonation accuracy following treatment (see Figure 2).

Table 3

Pitch Accuracy Mean and Standard Deviation in Cents

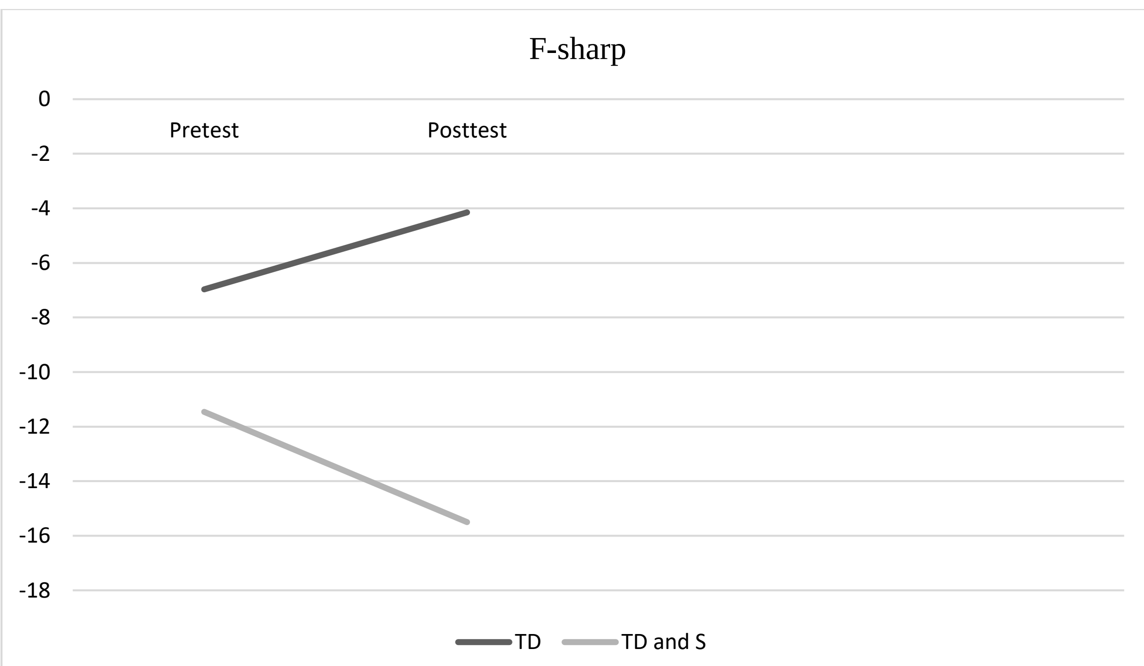
	F-sharp Pretest			F-sharp Postttest		
	$\bar{X}$	SD	N	$\bar{X}$	SD	N
TD	-6.97	17.52	22	-4.15	18.24	22
TD and S	-11.46	26.25	36	-15.5	24.17	36

Note. Numerical indicators are in relation to cent deviation from 0, which represents the pitch standard.

-

Figure 2

Pretest and Posttest Means in Cents for F-sharp



In relation to the pitch G4, there was not a statistically significant interaction between the treatment pitch and quasi-experimental condition, $F(1, 56) = 1.645$, $p = .205$. Neither tonic drone nor tonic drone and singing groups showed improvement in intonation accuracy from pretest to posttest as indicated in Table 4. The tonic drone and singing group trended farther from the pitch standard in the posttest than did the tonic drone group (see Figure 3).

Table 4

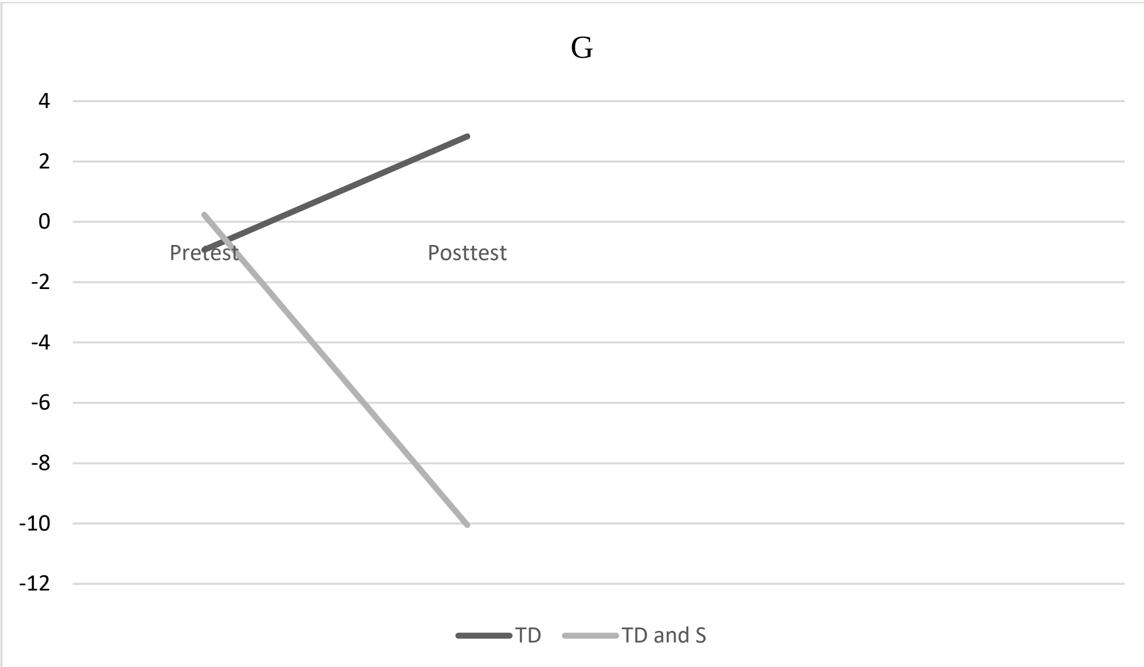
Pitch Accuracy Mean and Standard Deviation in Cents for G

	G Pretest			G Posttest		
	$\bar{X}$	SD	N	$\bar{X}$	SD	N
TD	-.93	15.92	22	2.83	20.01	22
TD and S	.23	22.06	36	-10.05	21.94	36

Note. Numerical indicators are in relation to cent deviation from 0, which represents the pitch standard.

Figure 3

Pretest and Posttest Means in Cents for G



The individual results for each pitch suggest the use of tonic drone and tonic drone and singing exercises have limited effect in improving the intonation accuracy of middle and high school string players.

CHAPTER V

DISCUSSION

The purpose of this study was to investigate the effects of tonic drone accompaniment and tonic drone accompaniment combined with singing on the intonation accuracy of middle and high school string players. Will pitch accuracy improve after tuning with a tonic drone accompaniment? Will singing the pitch with tonic drone accompaniment improve pitch accuracy?

Two groups were utilized in this quasi-experimental design. The following were research questions related to the purpose of the study: Will there be a significant difference in pretest and posttest scores within groups? Will there be a significant difference in pretest and posttest scores between groups? Will there be a significant difference in pretest scores between groups? Will there be a significant difference in posttest scores between groups? Will the use of a drone have a positive effect on either group?

Fifty-eight middle and high school string students from two public schools in north Mississippi participated in the study. Tonic drone (n=22) and tonic drone and singing (n=36) groups were assigned randomly through a coin toss. Pretests were performed to establish individual pitch accuracy of the students on three pitches: E4, F-sharp 4, and G4 (E3, F-sharp 3, G3 for cello; E2, F-sharp 2, G4 for bass). Treatment lasted for three weeks during which both groups met three times per week.

In week one of the study, following their tuning procedure, the control group first heard the pitch E4 as a sustained drone, then immediately played the pitch on their stringed instrument. This was repeated three times for a total of four presentations. The experimental group first heard the sustained drone pitch, sang the drone pitch, then played the pitch on their instrument. This was also repeated three times for a total of four presentations. The pitch F- sharp 4 was added to both groups' procedure during week two, followed by the addition of G4 during week three. Posttesting that was identical to pretesting was then performed to determine changes in intonation accuracy.

Summary of the Results

Two main research questions were of interest in this study. The first asked if hearing a sustained drone pitch before and while playing it would help improve intonation accuracy in string players. The second asked if hearing a sustained drone pitch, then singing that drone pitch, then playing it would help improve intonation accuracy in string players.

Summary of the Singing Task

No significant differences were found within groups from pretest to posttest. No significant differences were found between control and experimental groups on the pretest. However, significant differences were found between groups on the posttest. Neither group showed significant improvement in tuning accuracy from pretest to posttest. The tonic drone group performed more in tune that the tonic drone and singing group on the posttest. Results indicated singing a pitch before playing it produced no significant improvement in pitch accuracy from pretest to posttest. These findings are in agreement with previous research

(Bennett, 1994; Lyons, 2013; Mattingly, 2012; Silvey et al., 2019). Although no significant differences between or within groups were found from pretest to posttest, it is important to discuss these findings for each of the three pitches investigated. Concerning the pitch E4, both groups did show improvement, with the experimental group demonstrating the greatest improvement. The tonic drone group improved in accuracy on the pitch F-sharp 4, while the experimental group decreased in pitch accuracy. Neither group improved in accuracy in relation to the pitch G4. It should be noted that the tonic drone group was highly accurate in pitch at pretesting, leaving little room for improvement.

Overall, the singing group trended flat in relation to the pitch standard from pretest (M=101.17, SD=80.05) and posttest (M=88.86, SD=20.99). These findings contradict those of others (Bennett;1994; Lyons; 2013) who found an increase in sharpness from pretest to posttest. Additionally, the tonic drone and singing group performed flat across all testing periods as found in Laux (2015). Hopkins (2015) identified a tendency for string players to tune their instruments open strings flat. These findings contradict that of other research where a propensity for instrumentalists to perform sharp was found (Geringer, 1983; Worthy, 2000). Additionally, the singing group was highly accurate overall at the time of pretesting, so there was not a great deal of intonation improvement to be gained. Middle and high school students are, in general, self-conscious when it comes to singing in front of their peers. Although singing style was not included in treatment protocols, perhaps future studies should consider the possibility of incorporating a short, brief portion of the activity to vocalization technique. This might help address the flatness associated with poor projection brought on by a lack of confidence.

Some differences among this study and others should be discussed. This study implemented use of the syllable ‘la” for the singing element as was done in prior research (Elliot, 1974; Mattinjgly, 2012; Silvey et al., 2019). Some studies also implemented use of other verbal elements such as humming (Bennett, 1994; Silvey et al., 2019), and use of the syllable /Zu/ and /Zi/ (Lyons, 2013). I want to emphasize that it was not a function of this study to examine any possible relations with singing accuracy and playing accuracy, though students were encouraged to do so. As seen in other previous research (Elliott, 1974) this study employed the use of a pretest/posttest design that included both control and experimental groups. Some significant differences were employed among other studies. Bennett (1994) made use of a pretest/posttest design without a control while others (Lyons, 2013; Silvey et al., 2019) employed a posttest only design. Finally, quite a variety in length of studies can be seen in reviewed literature. These ranged from no treatment (Silvey et al. 2019) to an entire school year (Elliott, 1974). The reasons for such variety are many but include the purpose of the research and access to subjects. Although most of the studies came to the overall conclusion that singing a pitch before playing it did not produce a significant improvement in pitch accuracy, Elliott's research did find a significant improvement in tuning proficiency. It might be considered that if these studies had designs that were more congruent, similar conclusions would be made.

It has been my experience as a string student and my observation as an orchestra instructor that the key of D-major is addressed first in the classroom before moving on to additional key areas. This key allows for finger patterns to be identical on the D and A-strings of the violin and viola (Hamann & Gillespie, 2013). The cello also employs the same finger pattern on the D and A strings, while the bassist is required to shift.

The D-string was the only string used in this study, regardless of instrument. The first fingered note was E on the D-string. This could be considered the foundation, or pillar, of the additional researched pitches of F-sharp and G. If the initial fingered pitch of E was significantly inaccurate, it is likely the other two pitches would be also. In this study, the pitch E was addressed individually at the beginning of three class sessions. Ideally, more time and focus would be aimed on this pitch due to its structural importance in relation to the other sequentially addressed pitches of F-sharp and G. It is possible that the lack of significance between and within groups was influenced by the brevity of individual attention to the pitch E due to time constraints posed by the Covid pandemic.

Though insignificant, the experimental group showed greater improvement in intonation accuracy following treatment regarding the pitch E. The control group showed improvement on the pitch F-sharp while neither improved on the pitch G. In general, the control group stayed closer to the drone pitch than the experimental group did throughout the study, indicating improvement in two of the three treated pitches. It is possible that the act of vocalizing a pitch prior to playing it on a stringed instrument is a distracting exercise. This prospect should be investigated in future research.

Summary of Drone Use

The second research question asked, "Can the use of a drone in pitch-matching exercises improve intonation accuracy in string players?". It was my belief that hearing then playing a pitch with the presence of a continuous drone of the pitch being addressed would significantly improve intonation accuracy in middle and high school string players (Griswold, 1988; Harnum, 2013; Reel, 2005; Scherber, 2014). Posttest scores tonic drone (M=97.73, SD=19.17) and tonic drone and singing (M=88.6, SD=20.99) groups indicated the control group was significantly more accurate than the experimental group at the end of the study (p=.005), rejecting the null hypothesis. Overall, though not significantly, the tonic drone group showed slight improvement in pitch accuracy from pretest (*M*=95.06, *SD*=19.46) to posttest (*M*=97.73, *SD*=19.17). Recent studies of research using string players as subjects showed similar results. Laux (2015) found no improvement in the intonation accuracy of major scales when a drone was used. Violinists and violists participating in a study performed by Zabanal (2019) showed no significant results at posttesting when tuning to a sustained drone.

Published studies concerning the use of drones to affect change in intonation accuracy are limited (Springer et al., 2021). The studies that use string students as participants are typically brief in their presentation of a treatment condition (Springer et al., 2021; Zabanal, 2019) or somewhat longer as was done in a study by Laux (2015) which included seven treatment sessions. Along with the research presented here, it is hoped that continual efforts will be undertaken to examine this subject under sustained, lengthier conditions such as those employed by Elliot (1974).

There is a possibility that the sustained drone presented during these actions caused complacency in their pitch matching efforts (e.g. Coy, 2012). Research implementing the drone prior to singing and/or playing, while removing it during those actions should be investigated to determine if the drone presents a distraction.

Limitations

Some limitations within the current study should be discussed. The two groups were somewhat imbalanced in that the tonic drone group (*n*=36) was relatively larger than the tonic drone and singing group (*n*=22). This occurred due to the large number of students that were enrolled in one of the middle school string programs. The study was designed in such a way that all students were free to participate, increasing the probability that a true, heterogeneous student population would be represented. Future research might incorporate a method of making the groups more balanced in number. This research did not include a continuous drone during pretesting and posttesting, though it did during treatment sessions. The study was not designed to test pitch-matching facility, rather, it used pitch-matching as a tool to help promote intonation accuracy. It might be of use in future research to add the element of a drone during pretesting and posttesting. Additional research might also examine the effects of removing the drone sound while the pitches are being played on the instrument.

Due to an ongoing pandemic in relation to Covid 19 at the time of the study, access to human subjects was limited. The result of this situation caused the treatment period to be limited to a total of three weeks. In addition, orchestra classes for participants met a total of three times per week, rather than five times per week.

Suggestions for Future Research

In this study, the differences between singing and not singing a pitch prior to playing it were investigated. Further research might investigate differences between a control group that makes no changes to their daily classroom routine and an experimental group that sings a pitch before playing it.

The tonic drone group was significantly more accurate at posttesting than the tonic drone and singing group. Future research might determine if hearing a pitch before playing it produces significant results. This research could also employ use of a control group that makes no changes to their daily routine. A larger sample size might allow for comparison between instrument groups and age groups. Additionally, a study employing groups only comprised of the same instrument type could prove useful. Intonation accuracy decreased as the second and third pitches were added to the treatment in this study. It could prove useful to address only the first pitch, E. This might reduce the decrease in accuracy presented as the additional pitches were sequentially introduced.

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LIST OF APPENDICES

Appendix A: Teacher Instructions

Teacher Instructions

1. Tune all instruments
2. Inform students of intent to perform exercises
3. Use audio system to perform exercises with students
4. Remind students each exercise is performed a total of four times
5. Remind students to use a strong tone when both singing and playing (if applicable)

Appendix B: Pretest

and

Posttest Procedures

Pretest and Posttest Procedures

1. Welcome

2. Researcher will help tune your instrument, if necessary, place a pickup on your instrument, and explain the process.

3. You will be allowed 1 minute to play/warmup on your instrument if you desire.

4. Using the bow, on the D string, play the following pitches for a total of 4 counts each [E, F-sharp, G]

5. Before you play each pitch, you will hear a metronome for a total of four counts, quarter-note equals sixty beats per minute. The metronome will continue throughout the procedure. Once you have played a pitch for four counts, wait for four counts, then play the new pitch for 4 counts. Keep in mind that your playing data/information will be anonymous. In other words, no one is ever going to know how well you played. The testing will occur as follows, four counts per section:

[Metronome 4 beats/Play E 4 beats] [Metronome 4 beats/Play F-sharp 4 beats] [Metronome 4 beats/Play G 4 beats]

6. Once participants have completed the pretest, they will be returned to their classroom and a new student will be taken to be tested in the same manner as previously discussed.

Appendix C:

Consent to Participate in Research

Consent to Participate in Research

Study Title: The Effects of Singing Exercises on the Intonation Accuracy of Middle and High School String Players

Investigator	Faculty Sponsor
Starkey A. Morgan, Jr., M.M.	Michael Worthy, Ph.D.
Department of Music	Department of Music
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Key Information for You to Consider

- **Purpose**. The purpose of this research is to determine if singing exercises performed with drone accompaniment will help improve the intonation accuracy of middle and high school string students.
- **Duration.** It is expected that your child's participation will last three weeks.
- **Activities.** Your child will be audiotaped while playing three pitches on your instrument's D string. Your child will be asked to sing and play your instrument during normal orchestra class meetings.
- **Risks.** There are no known risks or stresses foreseen with this study.
- **Why your child might want to participate.** Intonation accuracy may improve with participation in this study. This research may provide valuable information concerning the addressing of intonation accuracy in the string music classroom.

☐ By checking this box I certify that I am 18 years of age or older.

What your child will do for this study

Your child will be "tested" during regular class orchestra time. For these tests, they will be recorded (audiotaped) in a separate location near their orchestra classroom. A total of two playing tests will be recorded, one before (pretest) and one after (posttest) implementation of the treatment. Tests will occur as follows:

1. Tests

   - The investigator will escort your child to the testing location (on campus). The D-string of their instrument will be tuned using a tuner. A microphone will be attached to their instrument to help record their playing examples.
   - The investigator will explain the recording process and what tasks the student will need to perform. A list of instructions describing the process will also be provided.
   - The student will be recorded aurally while playing the pitches E, F-sharp and G on the D-string. An audible metronome will be used during the recording process.

2. Treatment

   The treatment will last three weeks and occur during regular class time.

   - Students will hear, sing, then play, as a group, the pitches E, F-sharp and G on the D-string of their instrument.
   - A continuous pitch, or drone, will be sounding while they perform these exercises. A metronome will also be audible during these exercises.

Audiotaping

Your child will be audiotaped while he or she performs tests before and after the experiment.

Survey

Your child will be asked to anonymously fill out a general survey relating to musical experience, grade level, age and gender.

Confidentiality

I alone will have access to your recordings and any data derived from them. I will protect confidentiality by physically separating information that identifies your child from their responses.

Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary.

Right to Withdraw/Refuse

Your child does not have to volunteer for this study, and there is no penalty if they refuse. If your child starts the study and decides that they do not want to finish, they can just tell the experimenter. There will be no penalty for withdrawal from the experiment.

The researcher may terminate your child's participation in the study without regard to their consent and for any reason, such as protecting their safety and protecting the integrity of the research data.

IRB Approval

This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if your child needs more information.

When all your child's questions have been answered, then decide if they want to be in the study or not.

Statement of Consent

I have read the above information. I have been given a copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to participate in the study.

Furthermore, I also affirm that the experimenter explained the study to me and told me about the study's risks as well as my right to refuse to participate and to withdraw.

____ _______________

Signature of Participant/ Legally Authorized Representative Date

____ _______________

Printed name of Participant/ Legally Authorized Representative Date

Appendix D: Oral

Assent Form (Aged 7-13)

I would like to ask you to help me with a project I am doing at The University of Mississippi. If you agree you would first be aurally recorded playing three pitches (E, F-sharp and G) on the D string. Following the recording, you would perform brief singing and playing exercises in class for three weeks. At the end of those three weeks, you would again be recorded (aurally) playing the same three pitches as done in the first recording (E, F-sharp and G). **Y**ou will also be asked to anonymously fill out a general survey relating to musical experience, grade level, age and gender. What questions do you have about what you will do for me?

Will you do this?

Name: ______________________________ Date: ______________ Response: ___ Yes ___ No

Appendix E:

Information Sheet (18 or older)

INFORMATION SHEET (18 or older)

Study Title: The Effects of Singing Exercises on the Intonation Accuracy of Middle and High School String Players

Investigator	Faculty Sponsor
Starkey A. Morgan, Jr., M.M.	Michael Worthy, Ph.D.
Department of Music	Department of Music
164 Music Building	164 Music building
University of Mississippi	University of Mississippi
University, MS 38677	University, MS 38677
(662) 915-7268	(662) 915-7268
smorgan5@go.olemiss.edu	mworthy@olemiss.edu

☐ *By checking this box I certify that I am 18 years of age or older.*

Description
The purpose of this study is to determine the effects of singing exercises on instrumental pitch accuracy. If you decide to participate in this study, you will be asked to perform brief exercises which include singing individual pitches and playing those pitches on their instrument. These exercises will be performed as a group (you will not be asked to perform them alone in front of others) and will last for three weeks. The exercises will be executed during regular class meetings and last less than five minutes each time they are performed. I would like to audio record you playing three pitches on your instrument before and after the three weeks of exercises. I will use this information to determine if singing a pitch before playing a pitch on the instrument can improve pitch accuracy.

Risks and Benefits

There are no known risks or stresses foreseen with this study.

Confidentiality

I alone will have access to your recordings and any data derived from them. I will protect confidentiality by physically separating information that identifies you from your responses. Members of the Institutional Review Board (IRB) – the committee responsible for reviewing the ethics of, approving, and monitoring all research with humans – have authority to access all records. However, the IRB will request identifiers only when necessary.

Right to Withdraw/Refuse

You do not have to volunteer for this study, and there is no penalty if you refuse. If you start the study and decide that you do not want to finish, you can just tell the experimenter. There will be no penalty for withdrawal from the experiment.

The researcher may terminate your participation in the study without regard to your consent and for any reason, such as protecting your safety and protecting the integrity of the research data.

IRB Approval

This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Statement of Consent

I have read and understand the above information. By providing my signature I consent to participate in the study.

Signature of participant ______________________________ Date ________________

Printed name of participant ___________________________ Date ________________

Appendix F:

Letter to Parents

Dear Parent /Guardian,

My name is Starkey Morgan and I am a PhD candidate from the music department at the University of Mississippi. I am writing to invite your child to participate in my research study about singing and its relationship to playing in tune on a stringed instrument. Your child is eligible to be in this study because they are a participant in string orchestra at their school.

If your child decides to participate in this study, they will perform brief exercises which include singing individual pitches and playing those pitches on their instrument. These exercises will be performed as a group (they will not be asked to perform them alone in front of others) and will last for three weeks. The exercises will be executed during regular class meetings and last less than five minutes each time they are performed. I would like to audio record your child playing three pitches on their instrument before and after the three weeks of exercises. I will use this information to determine if singing a pitch before playing a pitch on the instrument can improve pitch accuracy.

Remember, this is completely voluntary. Your child can choose to be in the study or not. If your child would like to participate in this study, please complete the provided consent form and have them return it to their teacher. If you have any questions about the study, please email or contact me at **smorgan5@go.olemiss.edu.**

Thank you very much.

Sincerely,

Starkey Morgan

Appendix G:

IRB Application

The University of Mississippi
Office of Research and Sponsored Programs
Division of Research Integrity and Compliance – Institutional Review Board
100 Barr Hall – University, MS 38677
irb@olemiss.edu 662-915-7482

APPLICATION FOR EXEMPTION

Purpose: Many studies qualify for an abbreviated review, according to the federal regulations and university policy.

- **Part I of this form screens for a brief review.**
- **Part II of this form completes the abbreviated IRB application.**
- **Part III of this form gives instructions for obtaining the required assurances.**
- **The IRB makes the final determination on whether you must fill out a full application.**

Always download the most recent version of this form: http://www.research.olemiss.edu/irb/protocol/forms.

Prepare and send application form as a **Word** document. **E-mail the completed form and attachments (and forwarded email assurance if PI is a student)** to irb@olemiss.edu.
Note: Some class project studies may qualify for a classroom waiver of IRB Application. Instructors: see form here.

PART I — Screening

1. Do any of the following apply to your study?

Research Methods:

Clinical Treatment study ☐ Yes ☒ No
Exercise ☐ Yes ☒ No
X-rays ☐ Yes ☒ No
Collection of blood, urine, other bodily fluids, or tissues ☐ Yes ☒ No
Use of blood, urine, other bodily fluids, or tissues with identifiers ☐ Yes ☒ No
Use of drugs, biological products, or medical devices ☐ Yes ☒ No
Use of drugs, biological products, or medical devices ☐ Yes ☒ No
Use of data collected in the European Economic Area (EEA)* ☐ Yes ☒ No

Targeted Subjects:

Prisoners ☐ Yes ☒ No

Elements of Deception:

The study uses surreptitious videotaping ☐ Yes ☒ No
The study gives subjects deceptive feedback, whether positive or negative ☐ Yes ☒ No
The study uses a research confederate (i.e., an actor playing the part of subject) ☐ Yes ☒ No

If you checked Yes to any of the above, STOP HERE and fill out the FULL IRB APPLICATION FORM.

***Anonymous or Confidential?** Anonymous means (1) the recorded data cannot associate a subject with his/her data, and (2) the data cannot identify a subject. *Examples:* surveys with no names but with demographic data that can identify a subject (e.g., the only African-American in a class) are not anonymous.

***Sensitive Information?** Sensitive information includes but is not limited to (1) information that risks damage to a subject's reputation; (2) information that involves criminal or civil liability; (3) information that can affect a subject's employability; and (4) information involving a person's financial standing. *Examples:* Surveys that ask about porn use, illegal drug or alcohol use, religion, use of alcohol while driving, AIDS, cancer, etc. contain sensitive information.

***European Economic Area** - Collection of data in the European Economic Area (the 28 states of the European Union and Iceland, Liechtenstein, Norway, and Switzerland). Special considerations apply -if data are not 100% anonymous. See GDRP Guidance for more information

If using Qualtrics for anonymous surveys, see guidance here.

2. **The ONLY involvement of human subjects will be in the following categories** (check all that apply)
PLEASE READ CAREFULLY: MUCH CHANGED WITH NEW REGULATIONS, JANUARY 2019

☒ 1) **Educational Research:** Research conducted in established or commonly accepted educational settings, involving normal educational practices. Research is not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

☐ 2) **Surveys, Interviews, Educational Tests (cognitive, diagnostic, aptitude, achievement), Observation of Public Behavior (including video or auditory recording).** ***AT LEAST ONE OF THE FOLLOWING MUST BE CHECKED***

- ☐ (i) Information recorded by the investigator cannot readily identify the subject (either directly or indirectly)
- ☐ (ii) Disclosure of subjects' responses outside the research could **NOT** reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, educational advancement, employability, or reputation
- ☐ (iii) Information recorded by the investigator includes identifiers and the investigator specifies strong security measures to protect the data (e.g., encryption for electronic data; multiple locks for paper data). Minors are **NOT** permitted under this sub-category

☐ 3) **Benign Behavioral Interventions (BBI):** Research involving interventions in conjunction with collection of information from an adult subject through verbal or written responses (including data entry) or audiovisual recording, if the subject prospectively agrees to the intervention and information collection.

- BBI is limited to communication or interpersonal contact; cognitive, intellectual, educational, or behavioral tasks; manipulation of the physical, sensory, social or emotional environment
- Intervention Requirements:
  - brief duration (maximum intervention = 3 hours within one day; data collection may extend more hours & over days)
  - painless/harmless (transient performance task-related stress, anxiety, or boredom are acceptable)
  - not physically invasive (no activity tracker, blood pressure, pulse, etc.)
  - unlikely to have a significant adverse lasting impact on subjects
  - unlikely that subjects will find interventions offensive or embarrassing
  - no deception / omission of information, such as study purpose, unless subject prospectively agrees

AT LEAST ONE OF THE FOLLOWING MUST BE CHECKED

☐ (A) Recorded information cannot readily identify the subject (either directly or indirectly)

☐ (B) Any disclosure of subjects' responses outside the research could **NOT** reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation

☐ (C) Information is recorded with identifiers and the investigator specifies strong security measures to protect the data (e.g., encryption for electronic data; multiple locks for paper data)

☐ 4) **Biospecimen Secondary Research**: Secondary Research for which consent is not required: use of identifiable information or identifiable biospecimens that have been or will be collected for some other 'primary' or 'initial' activity, if **ONE** of the following is met: (i) biospecimens or information is publicly available; (ii) information recorded by the investigator cannot readily, directly or indirectly identify the subject, and the investigator does not contact the subject or re-identify the subject; (iii) collection and analysis involving investigator's use of identifiable health information when use is regulated by HIPAA; or (iv) research information collected by or on behalf of the federal government using government-generated or -collected information obtained for non-research activities.

☐ 5) **Research and Demonstration Projects on Federal Programs**: The study is conducted pursuant to specific federal statutory authority and examines certain federal programs that deliver a public benefit [call IRB for details if you think your study may fit].

☐ 6) **Food Tasting/Evaluation**: Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

PART II — Abbreviated Application

3. Project Title: Effects of Singing Exercises on the Pitch Accuracy of Middle and High School String Players

4. Principal Investigator: ☐ Dr. ☐ Ms. ☒ Mr. Starkey Morgan

Department: Music

Department Chair's email (for cc of approval): nmbalach@olemiss.edu

Work Phone: 6015599554

Home or Mobile Phone: 6015599554

E-Mail Address: smorgan5@go.olemiss.edu

If Principal Investigator is a student:

Graduate student:

☒ Dissertation ☐ Master's thesis

☐ Other graduate project

Undergraduate student:

☐ Senior thesis: ☐ SMBHC

☐ Croft Institute ☐ Other undergraduate project

Research Advisor: MICHAEL WORTHY (required for student researchers)

Department: MUSIC

E-Mail Address: MWORTHY@OLEMISS.EDU

Work Phone: 6629151277

Home or Cell Phone: 6628325132

5. Funding Source:

Is this project funded? ☐ Yes ⇨ ☒ No

If Yes, is the funding:

Internal: ☐ **Source:** Click to enter

External: ☐ **Pending/Agency:** Click to enter

☐ **Awarded/Agency:** Click to enter

PI(s) on external funding: Click to enter

6. **List ALL personnel involved with this research who will have contact with human subjects or with their identifiable data. All personnel listed here must complete CITI training OR the Alternative to CITI (ATC) training before this application will be processed*.**

NAME	POSITION/TITLE	ROLE ON PROJECT	Training completed: CITI	or ATC
PI Starkey Morgan	Graduate Student	PI	☐	☒
Advisor MICHAEL WORTHY	Faculty/Staff	Research Advisor	☐	☐
Click to enter	Select	Click to enter	☐	☐
Click to enter	Select	Click to enter	☐	☐

If space is needed to list additional project personnel, submit Appendix A.
***See Exempt Human Research Policy for training exceptions**

Research Methodology/Procedures

7. **Check all procedures below that apply to your study:**

☐ Pre-existing data or biological samples ⇨	- **Source of data:** Click to enter - **Do data/samples have identifiers?** ☐ Yes* ☐ No - **Describe how data will be secured** (e.g., encryption for electronic data; multiple locks for paper data). Click to enter *Minors are **NOT** permitted under this sub-category
☒ Observation	
☐ Oral history	
☐ Interview ⇨ ⇨ ⇨	Attach interview questions.
☐ Focus group ⇨ ⇨ ⇨	Attach topic and questions.
☐ Questionnaire or survey ⇨ ⇨ ⇨	Attach questionnaire or survey. **If online, describe platform (e.g., Qualtrics):** Click to enter
☒ Audio recording or videotaping ⇨ ⇨	Use and attach a release form if you plan to disseminate **quoted** comments or taped content. (This covers you and UM legally – Not for IRB purposes)
☐ The study has misleading or deceptive: ⇨ (1) study descriptions; (2) procedure explanations; and/or (3) survey instructions/rationales.	In the abstract, provide complete details and a rationale for employing misleading/deception information. Include **Appendix D** in your attachments.
8. **Consent Procedures:**	
☐ Oral ⇨ ⇨ ⇨	Attach script.
☒ Information Sheet/Cover Letter ⇨ ⇨	Attach. (**No subject signatures required**, see example here: Go to Examples and Templates, then 'Sample Information Sheet')
☐ **Not applicable, Explain:** Click to enter	

9. Project Summary **Briefly summarize your project using non-technical, jargon-free language that can be understood by non-scientists.** **See http://www.research.olemiss.edu/irb-forms for abstract examples.**	
Give a brief statement of the research question supporting the reasons for, and importance of, the research: The purpose of this study is to investigate the effects of singing exercises using a drone accompaniment on the pitch accuracy of middle and high school string players. The goal of the exercises is to improve the pitch accuracy of string players.	
Describe the ages and characteristics of your proposed subjects and how you will *recruit* them (attach recruitment script or materials to the application): Subjects will be middle and high school students approximately 13-18 years of age. Participation in middle and high school string orchestra from two schools in northern Mississippi is the criteria for participation in the study.	
For studies using only adult subjects, state how you will ensure they are 18+:	☐ First question on survey/interview ☐ **Other:** Click to enter ☒ Not applicable
***Briefly* describe the research design AND carefully explain how your study will meet each of the requirements of the category criteria you checked on Page 2: Two group design. Control and Intervention.**	
Give a *detailed* description of the procedure(s) subjects will undergo (from their perspective): Middle and High school string students will perform daily pitch matching exercises designed by the author as part of their regular class meeting with the goal of improving pitch accuracy. k to enter	

10. Appendix Checklist:

A. Additional Personnel not listed on first page of application?
☒ **No** ☐ **Yes** – complete Appendix A

B. Will the research be conducted in schools or child care facilities?
☐ **No** ☒ **Yes** – complete Appendix B

C. Does your research involve deception or omission of elements of consent?
☒ **No** ☐ **Yes** – complete Appendix D

D. Will your research be conducted outside of the United States?
☒ **No** ☐ **Yes** – complete Appendix E

E. Will your research involve protected health information (PHI)?
☒ **No** ☐ **Yes** – complete Appendix F **if applicable**

11. Attachments Checklist:

Did you submit:

a. survey or questionnaires?

☐ **Yes** ☒ **Not Applicable**

b. interview questions?

☐ **Yes** ☒ **Not Applicable**

c. focus group topics?

☐ **Yes** ☒ **Not Applicable**

d. recruitment email, announcement, or script?

☐ **Yes** ☒ **Not Applicable: No subject contact**

e. informed consent information letter or script?

☒ **Yes** ☐ **Not Applicable: No subject contact**

f. permissions for locations outside the University?*

☒ **Yes** ☐ **Not Applicable**

***if giving a survey, whether on or off campus, please ensure the person giving permission (e.g., the teacher of a class) has an explicit opportunity to see the survey before they give their permission for its distribution**

12. If using class points as incentives, are there alternative assignments available for earning points that involve comparable time and effort?

☐ **Yes** ☒ **Not Applicable**

13. If using an anonymous survey through Qualtrics and giving incentives in a separate survey, have you read and conducted the testing of the surveys according to the procedures here?

☐ **Yes** ☒ **Not Applicable**

PART III: ASSURANCES

Conflict Of Interest And Fiscal Responsibility

Do you or any person responsible for the design, conduct, or reporting of this study have an economic interest in, or act as an officer or a director of any outside entity whose financial interests may reasonably appear to be affected by this research?

☐ YES ⇨ ⇨ If Yes, please describe any potential conflict of interest. Click to enter

☒ NO

Do you or any person responsible for this study have existing financial holdings or relationships with the sponsor of this study?

☐ YES ⇨ ⇨ If Yes, please describe any potential conflict of interest. Click to enter

☒ NO

☐ N/A

Principal Investigator Assurance

PRINCIPAL INVESTIGATOR'S ASSURANCE

I certify that the information provided in the application is complete and correct. As Principal Investigator, I have the ultimate responsibility for the protection of the rights and welfare of the human participants, conduct of the research, and the ethical performance of the project. I will comply with all UM policies and procedures, as well as with all applicable federal, state, and local laws regarding the protection of participants in human research, including, but not limited to the following:

- Informed consent will be obtained from the participants, if applicable and appropriate;
- Any proposed modifications to the research protocol that may affect its designation as an exempt (brief) protocol application will be reported to the IRB for approval prior to being implemented.
- Adverse events and/or unanticipated problems will be reported to the IRB as required.

I certify that I, and all key personnel, have completed the required initial and/or refresher CITI or CITI Alternative courses in the ethical principles and regulatory requirements for the protection of human research participants.

Starkey Morgan, Jr. **12/18/2020**

Typed signature/name of Principal Investigator **Date**

RESEARCH ADVISOR'S* ASSURANCE (REQUIRED FOR STUDENT PROJECTS)

Email your Advisor with the following:

1. Email subject line: "IRB Advisor Approval Request from (your name)"
2. Your IRB submission materials as attachments
3. Copy and paste the statements below into the body of the email
4. Forward the reply email from your Advisor to irb@olemiss.edu along with your IRB submission materials attached.

***The research advisor must be a UM faculty member. The faculty member is considered the responsible party for the ethical performance and regulatory compliance of the research project.**

Please review my attached protocol submission. Your reply email to me will constitute your acknowledgement of the assurances below.

Thank you,
[type your name here]

As the Research Advisor, I certify that the student investigator is knowledgeable about the regulations and policies governing research with human participants and has sufficient training and experience to conduct this particular research in accordance with the approved protocol.

I agree to meet with the investigator on a regular basis to monitor research progress.

Should problems arise during the course of research, I agree to be available, personally, to supervise the investigator in solving them.

I will ensure that the investigator will promptly report incidents (including adverse events and unanticipated problems) to the IRB.

If I will be unavailable, for example, on sabbatical leave or vacation, I will arrange for an alternate faculty member to assume responsibility during my absence, and I will advise the IRB by email of such arrangements.

I have completed the required CITI course(s) in the ethical principles and regulatory requirements for the protection of human research participants.

VITA

Starkey Allen Morgan Jr. is currently an instructor of music at the University of Mississippi where he teaches Introduction to Music and String Methods. He holds a B.M. in cello performance from the University of Mississippi where he studied with Tian Sheng Li. He also has a M.M. in cello performance from the University of North Texas where he studied with Carter Enyeart. Mr. Morgan is currently pursuing his Ph.D. in music education from the University of Mississippi.

Mr. Morgan is currently principal cellist in the LOU Symphony at the University of Mississippi. His orchestral performing experience has included playing cello with the North Mississippi Symphony, Starkville Symphony, Corinth Symphony, Jonesboro Symphony, Pine Bluff Symphony, Memphis Symphony Orchestra, Irving Symphony, and the Mississippi Symphony Orchestra. He also served as principal cellist at the Orpheum theater for 5 years. Mr. Morgan accompanied many artists including Smokey Robinson, Johnny Mathis, and Andy Williams.

Before coming to the University of Mississippi, Mr. Morgan taught 3 years at the University of Memphis under the supervision of Peter Spurbeck. He has also taught orchestra in the Pine Bluff Public Schools, Tupelo Mississippi Public Schools, and the Memphis City Schools. Additionally, he taught cello and bass at Arkansas State University. He received the Outstanding Graduate Instrumentalist Award from the University of Mississippi in 2019.

RESUME

Starkey Morgan, Jr.

EDUCATION

2017-2022	Phd. Candidate in Music Education at the University of Mississippi (PhD completed November 2022)
1995-1999	Advanced work towards a Doctorate degree in Cello Performance University of Memphis Memphis, Tennessee
1994	Master of Music in Cello Performance University of North Texas Denton, Texas
1991	Bachelor of Music in Cello Performance University of Mississippi University, Mississippi

EXPERIENCE

2017-2022	Instructor; Introduction to Music, University of Mississippi Instructor: String Methods, University of Mississippi Instructor: Oxford String Project, University of Mississippi Principal cello: LOU Symphony, University of Mississippi
2019	Presented at the ASTA National conference in Albuquerque, NM.
2019	Presented at the Missouri Music Educators Conference
2006-2017	Mississippi Symphony Orchestra, section cello

2007-2008 Assisted in the hiring of orchestra members, directing orchestra as needed, Christ United Methodist Church, Jackson, MS

2006-2007 Music Associate for orchestra and youth choir, Broadmoor Baptist Church, Madison, MS

2004-2006 Strings Teacher, Memphis City Schools

2003-2004 Strings Teacher, grades 4-12, Tupelo Public School District, Orchestra director, Tupelo High School Orchestra

2001-2003 Strings Teacher, Pine Bluff School District, Pine Bluff, Arkansas
Director of Roby Junior High Orchestra
Responsible for assisting with fund-raising and recruitment

Summer 2001 Section Cello, Eureka Springs Opera Company, Eureka Springs, Arkansas

1997-2001 Principal Cello in productions such as *West Side Story, Peter Pan, Sunset Boulevard, Titanic, Beauty and the Beast and The Sound of Music*: Orpheum Theatre, Memphis

1998-2000 Adjunct Cello/Bass instructor, Arkansas State University, Jonesboro, Arkansas

1995-2001 Section Cello, Memphis Symphony Orchestra, Memphis, Tennessee Music Appreciation Instructor, Graduate String Quartet, and Section Leader of University of Memphis Orchestra, University of Memphis

1998-2000 Cello and Bass Instructor, Memphis City Schools String Camp

Spring 1994 Cello and Bass Instructor, Plano School District, Plano, Texas

1991-1994 Section Cello, Irving Symphony and Texas Philharmonic, Abilene, Texas

1991-1994 Section Cello, University of North Texas Symphony, UNT New Music Ensemble, UNT Chamber Orchestra, and University of North Texas Cello Quartet, Denton, Texas

1987-1991 Section Cello, Tupelo Symphony Orchestra, Tupelo, Mississippi

1989-1991 Section Cello, Greenville Symphony Orchestra, Greenville, Mississippi

1984-1985 Section Cello, Memphis Youth Symphony Orchestra, Memphis, Tennessee

PERFORMANCES AND MAJOR WORKS

2018 *In My Father's Eyes,* Julie Giroux, featured soloist with the University of Mississippi Wind Ensemble.

2004 *Requiem*, Rutter, Holmes Community College

2002	*Cello Concerto in cH.VII:1*, Joseph Haydn, Featured Soloist, Arkansas State University Concert Orchestra, The Forum, Jonesboro, Arkansas
1996	*Sonata No. 3, op.89,* Ludwig Van Beethoven; *Sonata for Violoncello solo, opus*. Jonesboro, Arkansas
1993	*Sonata in G Major*, G.B. Sammartini, String Department Recital, University of North Texas, Denton, Texas
1989	*Elegy, op. 47*, Jules De Swert, Solo Cello, Oxford Cello Quartet, University of Mississippi
1989	*Rondo for cello and piano, op. 94,* Antonin Dvorak; *Suite for Violoncello no. 3, in C major*, J.S. Back; *Concert for cello and orchestra in C major*, Joseph Haydn, Junior Recital, University of Mississippi
1988	*Quintet in E minor, op. 1-adagio quasi andante*, Student Ensemble, Sewanee Summer Music Center, The University of the South, Sewanee, Tennessee
1988	*Elegy, op. 47*, Jules Deswert, Solo Cello, Oxford Cello Quartet; University of Mississippi
1988	Guest Artist, Tupelo High School Orchestra Benefit Concert
1988	*Rondo for cello and piano, op. 94,* Antonin Dvorak; *Suite for Violoncello no. 3, in C major,* J.S. Back; *Concerto for cello and orchestra in C major,* Joseph Haydn, Junior Recital, University of Mississippi
1987	*Concerto in B-flat major, adagio,* Boccherina, First United Methodist Church, Tupelo, Mississippi
1987	*Sonata in E minor, op. 38, allegro non troppo*, Brahms, University of Memphis Department of Music cello recital, Memphis, Tennessee

AWARDS AND SCHOLARSHIPS

2019	Outstanding graduate instrumentalist, University of Mississippi
2017-2019	Ventress scholarship, University of Mississippi
1995-2000	Graduate Assistantship, University of Memphis
1991-1994	Performance Scholarship, University of North Texas
1988-1991	Performance Scholarship, University of Mississippi
1985-1988	Performance Scholarship, Memphis State University
1985, 1986	Mississippi Federation of Music Club Award
1988, 1989	Mary K. Scott Memorial Endowment Fund to attend Brevard Music Center
1987, 1988	Scholarship to attend Sewanee Music Festival, University of the South
1985	Wade Lagrone Honor Scholarship to attend Sewanee Music Festival

CELLO INSTRUCTORS

Peter Spurbeck, University of Memphis, Memphis, Tennessee; Carter Enyeart, University of North Texas, Denton, Texas; Carlton McCreery, University of Alabama, Tuscaloosa, Alabama'; John Holland, Tupelo Strings Program, Tupelo, Mississippi.
Performed in Master Classes with: Fritz Magg, Janos Starker, Yo Yo Ma, Kronos String Quartet, Linden Quartet, and Cavani Quartet.

REFERENCES UPON REQUEST