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The development of and relationship between vocal sight reading and instrumental sight reading of seventh, ninth, and eleventh grade orchestra students

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THE DEVELOPMENT OF AND RELATIONSHIP BETWEEN V ocal sight reading and instrumental sight reading of seventh, ninth, and eleventh grade orchestra students

by

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Submitted in partial fulfillment of the requirements for the degree of
Doctor of Musical Arts
2015
Dedicated to my late sister,

Radosveta Bruzaud,

a fine musician and scholar,

my model and inspiration
THE DEVELOPMENT OF AND RELATIONSHIP BETWEEN
VOCAL SIGHT READING AND INSTRUMENTAL SIGHT READING
OF SEVENTH, NINTH, AND ELEVENTH
GRADE ORCHESTRA STUDENTS

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ABSTRACT

Developing the music cognition competencies of both singers and instrumentalists
is one of the goals of school music programs. Vocal and instrumental sight reading are
used to indicate the level of development of cognitive skills in music. In this study, vocal
and instrumental sight reading served as a basis for determining public school orchestra
students' cognitive development in music.

Vocal sight-reading and instrumental sight-reading performances of 143 orchestra
students in 7th, 9th, and 11th grades were examined. Students' vocal sight-singing
accuracy was tested using the Vocal Sight Reading Inventory (Henry, 1999). Students' 
instrumental sight-reading was assessed using the String Performance Rating Scale
(Zdzinski & Barnes, 2002). The ANOVA procedure and the Welch test were applied to
determine whether there was an improvement in students' vocal and instrumental sight
reading with additional years of school orchestra experience.

Results from ANOVA analyses indicated that the differences in students'
instrumental sight-reading scores across the three grade levels were statistically
significant \[ F(2,140) = 34.50 \], \( p < .01 \). A post hoc Bonferroni adjustment revealed that the differences between each of the groups were statistically significant \( (p < .05) \) in favor of older and more experienced students. For vocal sight reading, the Tamhane procedure revealed significant differences only between students at the 7\(^{th}\) and 11\(^{th}\) grade levels, also in favor of the older students \( (p < .05) \).

Correlational analysis indicated that there was a strengthening of the relationship between students' vocal sight reading and instrumental sight reading as students progressed in grade level, indicating that they were continuing to develop their musicianship skills. The correlation between vocal sight-reading and instrumental sight-reading scores according to grade level were \( r = .36, p < .05 \) for 7\(^{th}\) grade, \( r = .52, p < .01 \) for 9\(^{th}\) grade, and \( r = .64, p < .01 \) for 11\(^{th}\) grade.

In this study I stressed the importance of both vocal sight-reading and instrumental sight-reading experiences for orchestra students and ultimately for all instrumental students. I also proposed theoretical models as to how the two skills are related and how they might be developed.
# TABLE OF CONTENTS

CHAPTER 1 – INTRODUCTION AND BACKGROUND .......................................................... 1
Aural Skills.......................................................................................................................... 1
Perceptual and Cognitive Musical Abilities................................................................. 2
Sight Reading...................................................................................................................... 7
Vocal Intonation Control................................................................................................. 9
Background...................................................................................................................... 13
Presence of Aural Skills in School Instrumental Programs........................................ 13
Importance of Aural Skills Training for Musicianship............................................... 16
Role of Aural Training for String Players................................................................. 17
End Results of Group Instrumental Instruction....................................................... 19
Statement of the Problem............................................................................................. 20
Purpose.......................................................................................................................... 21

CHAPTER 2 – REVIEW OF THE LITERATURE................................................................. 24
Perceptual and Cognitive Processes in Music Reading............................................... 24
Instrumental Sight Reading.......................................................................................... 24
Visual Perception in Instrumental Sight Reading....................................................... 30
Pattern Recognition....................................................................................................... 32
Tonal Sense.................................................................................................................... 36
Tonal Sense in Vocal Sight Reading............................................................................ 38
Tonal Sense in Instrumental Sight Reading............................................................... 40
Auditory Representations and Kinesthetic Memory.......................... 41
Auditory Representations.......................................................... 42
Notational Audiation and Priming Effect................................... 44
Notational Audiation and Kinesthetic Responses...................... 48
Additional Factors in Development of VSR and ISR................. 52
Pitch Matching and Accuracy................................................... 52
Melodic Dictation and Error Detection...................................... 56
Playing by Ear........................................................................... 57
Relationship between Vocal and Instrumental Sight Reading........ 59
Vocal Sight Reading and Instrumental Experience.................... 60
Summary.................................................................................... 63

CHAPTER 3 – DESIGN AND METHODOLOGY................................. 68
Restatement of the Purpose........................................................ 68
Research Instruments............................................................... 69
  Vocal Sight-Reading Instrument.............................................. 69
  Instrumental Sight-Reading Instrument................................ 73
  Demographic Information...................................................... 77
Design....................................................................................... 77
  Participants............................................................................. 77
  Recruitment.......................................................................... 78
  Pilot Study............................................................................ 79
  Testing procedures............................................................. 80
Concluding Comment

APPENDIX A Vocal Sight Reading Inventory, Form A

APPENDIX B Sight-Singing Test Melodies

APPENDIX C String Performance Rating Scale

APPENDIX D Sight-Reading Test Melodies

APPENDIX E Student Information Sheet

APPENDIX F Letter of Recruitment

APPENDIX G Student Assent Form

APPENDIX H Parent Consent Form

APPENDIX I Instructions for Participants

APPENDIX J Scoring Guidelines

APPENDIX K Scoring Guidelines Revised

APPENDIX L Sight-Reading Scoring Form

REFERENCES

VITA
LIST OF TABLES

Table 4.1 Main Study Interjudge Reliability............................................... 96
Table 4.2 Means and Standard Deviations for 7th, 9th, and 11th Grade
Students in VSR and ISR........................................................................ 97
Table 4.3 Means and Standard Deviations for Groups by Piano
Experience in VSR and ISR........................................................................ 98
Table 4.4 Levene’s Test of Homogeneity of Variances ......................... 99
Table 4.5 Welch Test of Equality of Means for VSR................................. 99
Table 4.6 Tamhane Multiple Comparisons Post Hoc Test for VSR
Among 7th, 9th, and 11th Grade Levels............................................... 100
Table 4.7 Analysis of Variance for 7th, 9th, and 11th Grade Levels
in ISR........................................................................................................ 101
Table 4.8 Bonferroni Multiple Comparisons Post Hoc Test for ISR
Among 7th, 9th, and 11th Grades......................................................... 102
Table 4.9 Measures of Association – Effect Size............................... 103
Table 4.10 Pearson Correlations Between VSR and ISR in Each
Grade Level............................................................................................. 106
Table 4.11 Pearson Correlations Between VSR and Each of the Five
ISR Components (Articulation, Interpretation, Intonation,
Rhythm, Vibrato)................................................................................ 107
Table 4.12  Levene’s Test of Homogeneity of Variances for VSR and ISR and Level of Piano Experience................................................. 111
Table 4.13  Welch Test of Equality of Means for VSR and Levels of Piano Experience........................................................................ 111
Table 4.14  Tamhane Multiple Comparisons Post Hoc Test for VSR Among the Groups with Different Levels of Piano Experience (No Experience, Beginning/Intermediate, Advanced)........................................................................ 112
Table 4.15  Analysis of Variance in ISR for Groups of Piano Experience........................................................................................................ 113
Table 4.16  Bonferroni Multiple Comparisons Post Hoc Test for ISR and Groups of Piano Experience (No Experience, Beginning/Intermediate, Advanced)................................................................. 114
Table 4.17  Total Correlations Between VSR and Piano Experience and ISR and Piano Experience................................................................. 115
Table 4.18  Summary of Correlations Between VSR and ISR for Each of the Groups of Piano Experience.................................................... 115
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.1</td>
<td>Relationship among VSR, ISR, and auditory representations in skilled musicians</td>
<td>12</td>
</tr>
<tr>
<td>Figure 5.1</td>
<td>Representation of the development of vocal and instrumental sight reading mediated by components of cognitive skills</td>
<td>133</td>
</tr>
<tr>
<td>Figure 5.2</td>
<td>Relationship among VSR, ISR, and auditory representations in unskilled musicians</td>
<td>137</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION AND BACKGROUND

Almost every instrumental director has heard at some point in his or her career the question: "How does this song sound?" Usually the question comes from a curious student who is looking at a new piece of music. The student may be determined enough to try to play it, but may subsequently feel that it did not sound correct, perhaps because it does not correspond to his or her expectation and mental representation of how the written music should sound. Then the student may ask "Is this right?" or may not even notice a mistake and proceed to learn the piece incorrectly. At this point most directors would jump in to correct the student.

Aural Skills

Many students are first introduced to instrumental music in school band or orchestra classes, and educational objectives for instrumental music often are classified and organized hierarchically within three "domains": cognitive, affective, and psychomotor (Radocy & Boyle, 2003, p. 274). The psychomotor objectives, and to a certain extent the affective objectives, are often met in the process of learning to play the chosen instrument. Because of the auditory nature of music, the cognitive objectives, or the "learning" of music, however, entail the development of auditory perceptual and cognitive processes and require a special focus on the part of teachers and students.
Perceptual and Cognitive Musical Abilities

Music psychologists have established that all humans share an innate base of musical abilities and tendencies (Radocy & Boyle, 2003; Sloboda, 1985; Thompson, 2009). Thompson (2009) listed two types of evidence to support this claim. The first type of evidence comes from research done with infants, who were found to exhibit some perceptual skills that seemed to be present at birth. Among such seemingly innate perceptual skills were the abilities to perceive and remember pitch sequences, discriminate pitches and rhythms, and differentiate between same – different tasks. In addition, infants have shown preference for consonance over dissonance and sensitivity to melodic contour. The second type of evidence pertains to the observation that the nature of cognitive skills is domain specific (e.g., language, music, spatial skills), suggesting that there are specialized inborn cognitive modules. This led Thompson to conclude that people must be born with perceptual and cognitive predispositions for music. This evidence is supported by Dowling (1999) who stated that "... infant auditory perception uses components that will remain important into adulthood" (p. 605). Dowling noted that one such component is melodic contour, which later in life may serve as a determinant for the understanding and processing of music structure and patterns.

People learn the music idioms with which they grew up through a process which Sloboda (1985) called "developmental enculturation". In the course of musical development children are first able to make aural discriminations based on their innate musical abilities. Children are first engaged in aural perceptual learning, which "... provides the listener with a fund of implicit knowledge of the structural patterns of that
music, and this implicit knowledge serves to facilitate the cognitive processing of music conforming to those patterns" (Dowling, 1999, p. 604).

Perceptions are organized into cognitions through what Radocy and Boyle (2003) called "knowledge structures" or schemata, which are developed from prior experience through the process of enculturation. Listeners analyze their acoustic environment, i.e. all the sounds that the ear perceives, through basic auditory processes which Thompson (2009) called auditory scene analysis. According to Thompson, music may engage and stimulate the cognitive processes involved in this auditory scene analysis.

According to Sloboda (1985), the cognitive stage in understanding music "... involves forming an abstract or symbolic internal representation of the music. The nature of this internal representation, and the things it allows a person to do with music, is the central subject matter of the cognitive psychology of music" (p. 3). While these representations are not directly observable, their existence and nature may be inferred from observations of music activities, such as creating, performing, memorizing, or finding wrong-sounding notes while listening (Sloboda, 1985). Thompson (2009) also maintained that "our understanding of music is stored in the brain as a mental representation" (p. 53) and that such mental representations are created through passive or active experience with the music of the culture through which the regularities of the music are internalized and form long-term knowledge schemata.

Lehmann, Sloboda, & Woody (2007) emphasized the role of mental representations for musical learning. They maintained that mental representations "underlie the whole range of musical skills, starting with remembering music to
reproducing and creating it” (p. 21). The authors claimed that the common denominator underlying these skills is the ability to "construct and manipulate mental representations" (Lehmann, et al., 2007, p. 21). McPherson (1993) designed a study to test a theoretical model of a "balanced" approach to instrumental training. The author used five music performance subskills of aural and creative instrumental performance: prepared performing, sight reading, playing from memory, playing by ear, and improvising, in which the visual, aural, and creative ways of performing and learning music were balanced and equally represented. A positive relationship was found among all subskills, further suggesting that there are common underlying processes involved in performing music.

Mental representations for sound (Lehmann, Sloboda, & Woody, 2007; Thompson, 2009), also known as psychological representations (Krumhansl, 1979), inner hearing and inner ear (Deutsch, 1971; Klonoski & Johnson, 2003), or audiation (Gordon, 2003 Edition), involve perceptual and cognitive abilities. Audiation, a term Gordon coined to represent profound understanding of music, "... takes place when we assimilate and comprehend in our minds music..." (p. 4). Lehmann, et al. (2007) noted that mental representations for music may have affective and kinesthetic aspects in addition to the auditory ones. Because I am mostly concerned with the pitch aspects of the mental representations, I will refer to them as auditory representations for pitch. In this study I examine the processes of sight reading, which involve music reading, and therefore I am concerned with the auditory representations evoked from music notation.

In order to understand how the auditory representations function, music
psychologists draw upon research by neuropsychologists. They have established that components of musical skill have specific brain localization (Sloboda, 1985). Halpern (2003), cited by Lehmann, Sloboda, & Woody, (2007), observed that hearing and imagining music activate the same brain areas and concluded that internal representations partly draw upon the same mechanisms that are involved in perception. In another study Halpern and Zatorre (1999), cited by Thompson, (2009), found that some of the same areas in the temporal lobe in the brain were activated during listening to melodies and imagining the same melodies. Thompson (2009) also noted that certain distinct qualities of music (e.g., melody, rhythm, grouping, harmony) are processed in specific neural areas, suggesting that, for example, melody and rhythm may have different processing areas in the brain. The author summarized these research findings:

. . . music engages multiple areas of the brain, some of which overlap with general auditory skills, others that may overlap with skills in related domains such as speech, and others that are domain specific. Many of these areas can be developed through extensive music experience and training. . . (p. 180).

Another cognitive ability that plays a role in learning and understanding music involves identifying patterns in the music and grouping them as single units or "chunks" (Sloboda, 1985). "Chinking", according to Lehmann, Sloboda, & Woody (2007), is the way people process information, i.e. people tend to group the perceptual input into meaningful units and " . . . search for patterns that allow them to process several units of information at the same time" (Lehmann, et al., 2007, p. 111). They also noted that "chunking is in essence a memory mechanism that links our perception to previously stored knowledge." (p. 112).
Helmbold, Rammsayer, & Altenmuller (2005) examined the differences between musicians and non-musicians in a wide range of what they called primary mental abilities using general intelligence measures and found that perceptual speed and the ability to identify hidden visual patterns were better for musicians than non-musicians. They suggested that differences in basic perceptual skills related to pattern recognition and processing might be prerequisites to or components of musical ability.

While people are born with a number of perceptual abilities, it appears that the cognitive mechanisms involved in reconstructing the outside world through mental representations are acquired in the course of long-term training (Lehmann, Sloboda, & Woody, 2007). The learning of music beyond the level of enculturation "... requires formal instruction, especially in music performance, but also in developing more sophisticated analytical and listening skills and the ability to read and employ conventional music notation" (Radocy & Boyle, 2003, p. 411). Such formal instruction is usually referred to as aural skills training.

Aural skills training is a conglomerate of related activities intended to develop and facilitate musical perception and cognition. Cook (1994) noted that such training "creates the interface between musical sound and the theoretical knowledge in terms of which musicians create, notate, and reproduce music" (p. 81). This training may include a variety of related aural activities: (1) performance on instruments and the related playing by ear and sight reading, (2) composition, (3) aural analysis consisting of error detection, pitch matching and recognition, interval and chord discrimination, (4) music dictation, and (5) sight singing, to name a few (Cook, 1994; Sloboda, 1985). As Sloboda
(1985) has noted, each musical behavior poses its own training problems and has with it a long pedagogical tradition. These activities may facilitate the understanding of music through the common cognitive denominator of auditory representations. Along with the other related activities listed above, such training could involve sight reading, which also could be used to demonstrate the level of development of the cognitive processes (Cook, 1994). Sight reading, whether it uses the voice or an instrument, encourages the development of music cognition and in turn becomes a key indicator of the presence and level of development of the music cognition.

**Sight Reading**

The ability to perform a piece of music when seeing its notation for the first time is called performing at sight (Randel, 2003). In sight reading, expert musicians translate the music notation symbols into kinesthetic actions, thus responding mentally and physically to the visual input (Lehmann, Sloboda, & Woody, 2007; Pratt, Henson, & Cargill, 1998). Lehmann, Sloboda, & Woody maintained that "... skilled readers reconstruct in their heads what the music should sound like based on the perceptual information. ... In the process, expectations and knowledge are integrated" (p. 117).

Instrumental sight reading (ISR) is "performing at sight on an instrument [which] requires the ability to grasp the meaning of musical notation quickly and call upon the relevant technical skills for execution; this should be accompanied by the skills of the ear as well" (Randel, 2003, p. 748). Expert sight singing is defined as "[t]he ability to sing at sight, which requires the ability to imagine the sound of pitches or intervals without the

The most obvious is the actual vocal performance itself which is used for testing. Beneath this external manifestation lies the more intangible, more important, and prior stage of aural imagery. Even this stage can be broken down further into two sub-stages: (a) the reading of notation (visual and grouping of symbols into patterns), and (b) the assignment of meaning in sound to these patterns. (p. 127)

Because sight singing involves decoding music notation, it is in essence a type of sight reading mediated by the voice. Some researchers (Daniels, 1986) concerned with choral instruction refer to sight singing as sight reading, thus indicating that the process is in nature sight reading, but making it indistinguishable from instrumental sight reading. Henry (1999) used the term vocal sight reading to denote the process of sight singing. In order to make a distinction from sight reading mediated by an instrument, I will refer to sight singing as vocal sight reading (VSR). Both ISR and VSR involve the development of auditory representations of the notation as a prerequisite for accurate tone production.

Whether the ability to form auditory representations from notation is better developed through vocal sight reading or instrumental sight reading is debatable. Because success in aural skills training can be measured by success in VSR (without the use of an instrument), a continuous synergistic loop is created: singing may reflect the ability to hear and comprehend music notation mentally, which can be applied back when performing through singing or playing. Similarly to ISR, which necessitates the presence of some technical facility on an instrument, VSR requires some development of the vocal skills to achieve vocal control of the intonation. Because of the common underlying
process of auditory representations, good VSR may facilitate good ISR, provided that technical facility on the instrument is sufficiently developed. When students learn to apply auditory representations through vocal sight reading they could transfer this ability to instrumental sight reading and possibly improve it.

**Vocal Intonation Control**

The process of mastering technical facility on an instrument to achieve intonation control depends on the type of instrument. Zdzinski & Barnes (2002) noted that "in string performance, intonation is a technical challenge that is determined by left-hand technique. . ." (p. 253). Establishing left-hand technique is familiar to any string pedagogue, hence it will not be discussed here; however, a few words about the vocal techniques involved in achieving correct intonation with the voice may be useful.

Singing in general accomplishes three objectives. First, using one’s voice as an instrument for tone production and receiving instant feedback by hearing it helps ingrain the sense of pitch in a kinesthetic, not just aural way (Sundberg, 1987). Secondly, when singing, the person hears his /her voice and compares it to an external stimulus (a tone on an instrument, or another voice) or an internal stimulus (the image of the tone in one’s mind). Finally, through such constant comparison, singing improves intonation and develops inner hearing (Deutsch, 1971).

Sundberg (1987) noted that through training of the voice singers develop a proprioceptive memory, which is useful in performing intended shifts in phonation frequency when changing the pitch. Sometimes this memory is called "muscle memory for pitch" by singers. Phonation frequency changes reflect muscular activities in the
singer in the same way that changes of pitch require certain muscular activities by the instrumentalist. The pitch change should lead to the correct target (sound) immediately for both a singer and an instrumentalist. Sundberg (1987) stressed that "the singer, before starting the muscular maneuver, must 'know' exactly what muscles to contract, at what moment, and to what extent; the goal must be accurately known before the departure" (p.180).

Similarly to these observations, Klonoski and Johnson (2003) wrote:

Singers need to learn how to connect their inner ear to the physical vocal process before initiating sound so they can accurately reproduce a pitch on the first attempt. . . . Engaging and connecting the mind’s ear to the vocal process is critical to developing independent singers with good intonation. (p. 35)

They added that the inner ear will not establish a connection with the voice if external sound sources (i.e. instruments) are used all the time. The process appears to be quite complex and works both ways: singing is necessary to develop the inner hearing and, conversely, the inner hearing manifests itself through singing. Similarly to Sundberg, Klonoski and Johnson (2003) acknowledged that the vocal mechanism needs to be prepared to reproduce the mental image before singing aloud. The technique, according to them, that will prepare the vocal mechanism to perform the correct kinesthetic motions to produce the mental pitch is subvocalization. The authors suggested that failure to enact the pure mental image of pitch through subvocalization is the reason for intonation problems in singing. They stated, "The ultimate goal of subvocalization as it pertains to singing is to enact the pure auditory image, engage the vocal mechanism, and assess intonation all in advance of singing out loud" (p. 38). Klonoski and Johnson suggested that enacting the mental image through subvocalization increases the kinesthetic and
auditory memory for that image and the likelihood for recall. Klonoski (2006) also stressed the critical role played by singing during listening activities in enabling and encouraging inner hearing for music to function and pointed out that "... we must teach [students] to use their voices, through subvocalization, to assist their inner ear in understanding music" (p. 59). It appears that successful VSR is dependent upon the proper control of the voice in addition to the ability to imagine the target pitches (Sundberg, 1987).

Training the voice through vocalization and subvocalization to achieve control of the intonation so that VSR more accurately reflects the development of auditory representations is quite similar to training on an instrument. Instrumentalists develop kinesthetic memory as a result of long training. Similarly, singers also need proper and prolonged training in order to develop a high level of voice and pitch control, especially if VSR is to be used to evaluate the development of auditory representations.

It appears that skilled vocal and instrumental sight reading involve quite similar processes. For an instrumentalist the target (correct intonation) is both internal (auditory representations from the notated music) and external (kinesthetically on the instrument), whereas in singing the target is internal and is achieved by processes of proprioceptive memory and the use of auditory representations. In both processes the auditory representations from notated music are present before, during, and after the sound is produced and serve as criteria for the proper application of the visual and kinesthetic components of sight reading (Wolf, 1976).
The theoretical postulate in this study is that VSR and ISR are related through the underlying cognitive process of auditory representations; therefore, both activities can be used to indicate the level of development of the auditory representations. Both require control of the performing medium – voice or instrument; therefore, any activities that contribute to the development of vocal control, instrumental technique, and auditory representations may contribute to the accuracy in VSR and ISR.

Figure 1.1 illustrates the similarities between VSR and ISR processes of skilled musicians. When the auditory representations from music notation are present and control of the performing medium is achieved, the two processes seem to function in a similar way. In this case, reading music notation results in a performance with correct intonation. In addition, the end result of both processes would accurately reflect the development of the auditory representations.

![Diagram showing the relationship between VSR, ISR, and auditory representations](figure)

Figure 1.1. Relationship of VSR and ISR to auditory representations in skilled musicians
Background

Presence of Aural Skills Training in School Instrumental Programs

Musicians generally agree on the important role that aural skills training plays in performers' overall confidence in their musical abilities and for their success in musical activities. As mentioned earlier, VSR and ISR are indicators of cognitive skills in music and are used for developing and demonstrating the ability to learn music, understand music, and make musical decisions. Some common cognitive behaviors between the two processes include translating musical notation into sound (either instrumental or vocal), forming auditory representations of the musical notation, and grouping the information into patterns and "chunks". It is possible that all of these behaviors could be acquired through instrumental sight reading, and consequently, there is a traditional emphasis on ISR in instrumental classes. While instrumental sight reading is considered a valuable competence for instrumentalists (Rogers, 1984/2004) and its mastery can contribute to students' chances for a lifelong engagement with music (Lawrence & Dachinger, 1967), an exclusive focus on it would not be sufficient to provide the needed self-reliance and independence (Gordon, 2003 Edition). Colwell (1963) stated:

. . . in sight singing the individual must rely solely upon his memory of pitch-intervals and connect these with the notes he sees in the score. Thus "earmindedness" is the basic essential in sight singing. On the other hand, the instrumentalist who sight-reads may only remember the proper fingering or hand position indicated by the notes and may never actually hear what he sees on the page until he plays it. Therefore, it seems logical that vocal experience should result in greater auditory-visual discrimination than does instrumental experience. (p. 123)

Many instrumental programs, however, do not include VSR as an activity complementary to ISR in order to develop in students correct auditory representations from notated music.
in organized and systematic ways (Colwell, 1963; Liperote, 2006; May & Elliott, 1980; Robinson, 1996).

Students entering instrumental music programs generally do not have developed cognitive skills through formal music training prior to starting to play an instrument or engaging in reading music notation. In regard to students’ readiness for learning to play an instrument, Liperote (2006) observed that in the early formative years in elementary school students often did not receive sufficient music instruction and noted that

[this] reduction in early exposure to and active participation in music has significantly affected the development of music-readiness skills so crucial to beginning instrumental music instruction. Because of this, children should be engaged in aural-skills activities from the moment they enter our classrooms, and these activities will ultimately transfer to increased performance skills on instruments. (p. 48)

Conway (2003) also cautioned that teachers should not assume that beginning band and orchestra students have the readiness to play a musical instrument, and that "... musicianship skills should be taught as part of beginning instrumental classes" (p. 27). As a common practice, however, upon entering the instrumental music classroom students are given an instrument and expected to start playing as soon as possible. In many cases they learn to play as they concurrently learn music notation. Dalby (1999) noted the challenges that instrumental students were facing: "... in music education we try to teach students to read notation that they cannot yet audiate. Worse, we sometimes do so while they are struggling with the initial physical challenges of an instrument" (p. 23). This type of instruction tends to keep music reading separated from the development of perceptual abilities and cognitive understanding of music.

Developing cognitive processes and building connections between them are the
objectives of aural skills training and are the subject of Gordon's *Music Learning Theory*. Despite the availability of a comprehensive method for developing music understanding while acquiring instrumental skills, based on MLT, many instrumental music teachers at middle- and high-school levels do not include aural training in their classes in a systematic way (Dalby, 1999; Hammer, 1963). Robinson (1996) summarized the issue of inclusion of aural training in instrumental programs:

> Most music educators would agree that singing is an activity critical to the development of musical understanding and aesthetic sensitivity. Why is it, then, that many band and orchestra directors at the elementary, middle, and high school levels are reluctant to incorporate vocalization activities into their instrumental instructional programs? (p. 17)

Wolbers (2002) also pointed out that "when a child begins the study of a band or orchestra instrument, the use of the singing voice in class is often overlooked. . . . An important tool for developing ensemble and individual musicianship is being ignored" (p. 37).

Vocal sight reading often is neglected in choral music as well, and there is a lack of consistency among choral directors regarding inclusion of VSR instruction (Daniels, 1986, 1988). Possible reasons for the state of VSR in school choral programs are numerous, but data from a survey by Demorest (2001) indicate one of the primary reasons to be "an inverse relationship between the amount of performing an ensemble does and the amount of sight-singing training the members receive" (p. 30).

Music educators generally believe that forming accurate aural representations from notation is a valuable competency for students to possess, that this process is essential for developing musicianship and musical independence. Nevertheless, aural
training remains insufficiently addressed in both instrumental and choral programs to allow students to fully reach their music potential. Vocal sight reading in particular continues to be an underused activity for both instrumental and choral students, despite its importance for developing and evaluating the cognitive processes involved in music.

**Importance of Aural Skills Training for Musicianship**

Musicianship skills and musical independence are the two most often recognized benefits of aural skills training and its component VSR. Demorest (2001) noted that, "beyond the requirements of external standards, there are more fundamental reasons to teach sight singing. The confidence and independence that come with developing one's personal musicianship are something that lasts a lifetime" (p. 3). The development of auditory representations frees the musician from constant reference to an instrument and provides the independence needed for lifelong engagement with music. Boyle and Lucas (1990) and Henry (2004) also suggested that the development of musicianship is a worthy goal in choral programs because of its importance as a tool for achieving musical independence. Rawlins (2005-2006) expanded the issue of aural training from just choral to include instrumental classrooms, saying that, "of all the skills required to master a musical instrument, perhaps none is more important than a well-trained ear" (p. 26).

The goal of music education in the schools should not be just the development of perceptual, kinesthetic, and affective skills; it also should include the cognitive skills that constitute the learning of music (Radocy & Boyle, 2003). Lehmann, Sloboda, & Woody (2007) maintained that "sight-reading serves as proof that a young person . . . has conceptually mastered the music system" (p.109). Insofar as instrumental sight reading is
an indicator for a student's level of music literacy and technical proficiency, and a "... test of comprehension of the musical symbol system" (Gromko, 2004, p. 7), this provides the rationale for its inclusion in instrumental programs. Vocal sight reading, an arguably more direct and acute indicator of aural skills, also manifests itself in the ability of the musician to think in sound, i.e. to connect the note symbols to the sounds, hear the sound internally, and form aural representations of the music without the external help from an instrument; VSR therefore is equally worthy of inclusion in instrumental programs. In this vein, Lucas's (1994) statement applies equally to choral and instrumental students:

The ability to interpret musical notation independently is a useful skill for the choral musician. Without a functional understanding of musical notation, the singer is limited to learning music aurally and is therefore dependent on others when learning new repertoire. (p. 203)

May and Elliott (1980) also stressed the importance of aural skills development for all types of ensemble groups:

Music educators generally agree that ensemble participation should offer the student more than just the mechanics of vocal production or how to manipulate an instrument. Instruction leading to development of other music skills, including aural abilities, is considered important for all ensemble participants. (p. 155)

Well-developed cognitive music skills are the foundation upon which a student builds technical expertise on an instrument and provide important bases for musical decisions.

**Role of Aural Training for String Players**

Aural skills are especially important to students learning string instruments because placement of the fingers to achieve correct intonation (beyond the necessary technical facility) is ultimately dependent on the developed auditory representations. Some string teachers place pieces of tape on the fingerboard where fingers should go, but
this practice sidelines students' learning to use their aural skills for reference and ultimately impedes students' development of self-reliance (Gordon, 2003 Edition). When students sing from notation, they connect the symbolic representation of the passage to the actual sound through the auditory representation that they form of that sound (Gordon, 2003 Edition). When students sing what they are about to play and form a mental image of the sound before it is produced on the instrument, they connect the sound to the motion necessary to produce it when they actually attempt to play it (Hiatt & Cross, 2006). Through reading notation, singing, and listening activities, students create connections between sound and its visual symbol. In this process, the singing may be used to demonstrate that sound has been correctly derived from notation and compared to the auditory representations which then need to guide the fingers on non-fixed pitch instruments. This is why VSR possibly should become a complementary activity to ISR. Hiatt and Cross (2006) suggest that

while the student is acquiring a mental repertoire of tunes, technical instruction begins at a basic level. . . . As technical instruction progresses, the student must learn to associate the physical motions used to produce sound on the instrument with a mental sense of pitch. . . . Most instrumental applied students learn to play by learning fingerings; in the long run, a truly musical process-audiation-is much more reliable . . . Those who read notation without audiating what they see in notation . . . are actually faking . . . (pp. 48, 49)

Learning technical skills on an instrument and developing the requisite cognitive skills for instrumental performance, including music reading, obviously takes time and requires some focus on the respective skills. In addition to playing, singing also could be a means for developing students' cognitive skills, and there are several approaches that could be helpful to teachers in their efforts to incorporate singing in instrumental classes.
Singing instrumental songs, as suggested by Dunlap (1989), singing from notation (Dalby, 1999; Hiatt & Cross, 2006), singing tonal patterns (Gordon, 2003 Edition; Grutzmacher, 1987; Henry, 2004), or a combined method of singing and playing of intervals, as used by Schlacks (1981), are some available approaches.

**End Results of Group Instrumental Instruction**

As early as 1941, Lowery voiced concern regarding an instrumental method of instruction that was oriented toward technique while largely disregarding musicianship. In the same vein, Strange (1987) maintained that "dextrous accomplishments, however, can become the end result rather than the means of developing musical insight and conceptual understanding. The student becomes a technician lacking a complete musical education" (p. 4). Conway (2003) also cautioned that "... for many children, the coordination of executive skills may take over, and they will never be able to sing and move. As they advance in instrumental music, these students may increase their executive skills, but they may never be able to perform with good rhythm and intonation" (p.27).

The music education that students receive in school has an impact on their personal future endeavors with music, both avocational and professional, and also on the success of collegiate, professional, and church music organizations (Daniels, 1988). To Butler’s (1997) question of "how well does public-school music education prepare students to succeed in college-level aural training?" (p. 43), many music education scholars would answer that incoming music majors lack adequate aural and conceptual understandings of music. Smith (1998) noted that for some students ear-training classes
at the college level seem to be among the most difficult ones, but also the most beneficial in their preparation as professional musicians. One possible reason for the difficulties could be that college is the first level at which students are introduced to aural training in a systematic and comprehensive way, with the exception of the recent phenomenon of AP (advanced placement) classes in music theory at the high school level which incorporate some aural training. Music students entering college are required to take music theory coursework with aural, oral, and performing components and to develop within a few semesters an understanding of the music fundamentals (Harrison, 1990). Harrison also pointed out that some students succeed in all components while others fail to master any of them.

Aural training could and probably should start the moment students enter the instrumental classroom (Liperote, 2006) and continue through the years spent in band or orchestra regardless of whether or not they intend to make music their profession. If the student’s interest is professional, ear training courses in college would no longer seem such an obstacle impossible to surmount; if their interest is avocational, they will have a skill that will help them be lifelong independent music learners.

Statement of the Problem

The importance of developing cognitive skills for all participants in traditional secondary school ensembles (choir, band, or orchestra) has been well established through previous research. Vocal and instrumental sight reading are used as a means for both developing and evaluating aural skills. The relationship between the two components of aural training is evident in the cognitive processes they share, particularly in the
formation and use of auditory representations of musical sound. According to many cognitive psychologists, the utilization of auditory representations is a critical factor for success in music activities. Because singing from notation is a complementary activity to playing an instrument in developing auditory representations from notated music, both VSR and ISR should be integral aspects of instrumental music programs. In reality, students in band and orchestra classes are usually engaged in instrumental sight reading on a regular basis, but vocal sight reading typically does not receive equal attention.

The present inquiry is based on the premise that vocal and instrumental sight reading are related behaviors through the underlying process of forming auditory representations from notated music. Both experiences might facilitate students' development of cognitive understanding of music and indicate whether the music cognition develops over time. Because of the focus on ISR in instrumental classes, I sought to examine the extent to which auditory representations for pitch are developed through instrumental training by comparing students' ISR with their VSR and to determine whether instrumental training would enhance VSR.

**Purpose**

The purposes of this study were to (1) investigate the vocal and instrumental sight reading of 7th, 9th, and 11th grade orchestra students, and (2) examine the relationship between vocal sight-reading and instrumental sight-reading abilities within each grade level and the overall relationship between VSR and ISR of string orchestra players in order to look for growth in these abilities and to examine the extent to which they facilitate the development of aural representations for pitch. Additional purposes were to
determine whether piano experience accounts for any differences in VSR and ISR among the grade levels and to examine the relationship between VSR and ISR based on students' years of piano experience.

The first research hypothesis was that there are significant differences in VSR scores among 7th, 9th, and 11th grade orchestra students. The second research hypothesis was that there are significant differences in ISR scores among 7th, 9th, and 11th grade orchestra students. The third research hypothesis was that there is a relationship between VSR and ISR scores of the students. Ancillary hypotheses were that there is a significant difference in the vocal sight reading and instrumental sight reading of students who play piano and those who do not and that there is a relationship between VSR and ISR based on the piano experience of the students.

The following primary questions were addressed:

1. Are there significant differences among 7th, 9th, and 11th grade string instrumental students' vocal sight reading?

2. Are there significant differences among 7th, 9th, and 11th grade string instrumental students' instrumental sight reading?

3. Is there a relationship between VSR and ISR overall and at each grade level?

The following ancillary questions were addressed:

1. Are there significant differences in VSR and ISR between students who have piano experience and those who do not?

2. Is there a relationship between VSR and ISR of students with piano experience and those without piano experience?
The development of VSR and ISR was initially explored through review of the related literature. I also sought to examine the relationship between them in order to infer the development of aural skills. Based on the extant research and the results from my study, I would propose theoretical models that attempt to explain the development of and relationship between vocal sight-reading and instrumental sight-reading competencies.
CHAPTER 2
REVIEW OF THE LITERATURE

The importance of aural skills training on students’ success in music has long occupied researchers' interest and has been the focus of a number of studies. Specifically, researchers have sought to determine which components contribute the most to the development of cognitive skills, to analyze relationships among them, and to identify ways to improve aural skills instruction. The goal of the literature review is to identify (1) the perceptual and cognitive abilities that are involved in development of aural skills, (2) the factors that have an effect on the development of vocal and instrumental sight reading, and (3) the extent to which the relationship between VSR and ISR has been examined previously.

**Perceptual and Cognitive Processes in Music Reading**

**Instrumental Sight Reading**

Several authors have supported the notion that instrumental sight reading, which they simply refer to as sight reading, is a compound competence that requires acquisition of several perceptual and cognitive abilities in order to be competently performed. It is developed through the combining of perceptual, cognitive, and performing skills in close interrelationship and interconnectedness. Kopiez and Lee (2008) observed that "sight reading as a skill . . . can best be described in terms of a component structure" (p. 54). This concept was supported by Waters, Underwood, & Findlay (1997) who stated that "given that sight-reading represents a complex transcription task, it is apparent that many different types of processing ability must underlie sight-reading expertise" (p. 477).
Among those abilities they listed pattern recognition skills, ability to anticipate the flow of music, as well as kinesthetic skills. In the following studies some of the perceptual and cognitive skills involved in sight reading were examined. Although I did not specifically examine many of these processes, it is helpful to recognize the broad perceptual and cognitive bases that underlie music reading.

Support for the idea that music reading involves perceptual and cognitive processes was provided by Sloboda (1984) who examined existing research on music reading with regard to differences between cognitive processes of good and poor readers. From this pool of research studies the author extracted two most commonly found contrasting hypotheses about the nature of music reading. Based on the reviewed studies the first hypothesis supported the view that music reading requires both music perception and cognition. Sloboda summarized that it involves

(1) a typical "skill effect" such that better readers have better visual memories for notation and show more sensitivity to structural configurations in the stimuli and

(2) that much of what is read is analyzed for musical significance prior to the formulation of motor commands for response. (p. 222)

The second hypothesis stated that "music reading is a visuo-motor task that does not engage any of the cognitive processes specific to and necessary to musical perception" (p. 223). According to this hypothesis, visual perceptions are converted directly to motor actions and the performer is able to hear the visual stimulus only after the notes have been produced; therefore musical perception or cognition happens after the reading. Sloboda expressed a preference for viewing music reading as a particular type of music cognition, therefore supporting the first hypothesis.

A comprehensive model of how sight reading works was proposed by Wolf
(1976) who divided the sight-reading process into reading and mechanical ("motoric") skills. According to this model, the reading component enables musicians to process music notation (through visual and auditory clues from the music), and the mechanical component allows them to react to music notation in a kinesthetic way. Wolf interviewed four pianists possessing exceptional sight-reading abilities and proposed a cognitive map of music reading based on an information-processing model. This map was based on the premise that sight reading is a task in pattern recognition and that there is a close relationship between music and text reading. The similarity comes from the fact that musicians do not look at individual notes; rather, they look for patterns similar to the way text readers look for words. The cognitive map has two components – memory and kinesthetic -- and seven steps, during which the external input (notation) with its visual, auditory, and kinesthetic components is recorded in the appropriate sensory registers that trigger the respective visual, auditory, and kinesthetic imagery. The input information is passed through long-term memory to be matched with similar information, which is sent in a condensed form to short-term memory and processed as chunks of information. Messages are sent to the "effector" systems that trigger commands for actions. Because both short- and long-term memory systems are involved during sight reading, Wolf concluded that "it appears to be the primary reliance on different memory storage systems which separates the skilled performer from the skilled sight-reader" (p. 164). Besides note/pattern recognition (that has become quite automatic for most good sight readers, Wolf noted), another aspect of sight-reading skill is the speed with which visual processing is converted into kinesthetic action.
It appears from these studies (Sloboda, 1984; Wolf, 1976) that pattern recognition skills and memory skills, specifically the dual reliance on both short- and long-term memory, play an important role in music reading. Memory skills contribute to successful pattern recognition while pattern recognition contributes to successful music reading in an interconnected way.

The connection among instrumental sight reading, pattern recognition, and memory also was evident in Stebleton's (1987) study. The author explored existing research focusing on predictor variables of sight-reading ability and on individual difference variables. Studies on predictor variables for perceptual and cognitive abilities suggested that keyboard psychomotor skill, note-reading skill, and rhythm-reading ability were significant predictors for success in sight reading. Word reading and IQ were significant predictors of individual differences in sight-reading achievement. Stebleton’s review of literature revealed that "proficient readers retain more notes in a visual memory trace . . . have a greater ability to recognize patterns in music . . . and to retain information about the contour of patterns" (pp. 13, 14). The author attributed some of the differences in sight-reading skill to individual inherent factors, while others were the result of teaching methods, pointing to the notion that perceptual and cognitive aspects of sight reading can be developed and improved as a result of teaching and learning.

A number of other researchers have acknowledged the complexity of instrumental sight-reading competence and have sought to organize its structural components into perceptual and cognitive skills. Gromko (2004) examined the relationships among sight reading, tonal and rhythmic audiation, visual field articulation, spatial orientation and
visualization, and academic achievement. The study was based on the premise that music sight reading with and without playing activates areas of the brain that process spatial information and that high performance on spatial orientation or spatial visualization tasks might predict sight-reading achievement. High school band students (N = 98) took a series of tests, including the *Advanced Measures of Music Audiation* (Gordon, 1989), the *Kit of Factor Referenced Cognitive Tests* (Ekstrom, French, Harman, & Dermen, 1976), and the *Watkins-Farnum Performance Scale* (Watkins & Farnum, 1954). The best predictors of sight reading were determined using a stepwise regression analysis. The results suggested that sight-reading success can be predicted by a combination of cognitive abilities such as language reading comprehension, rhythmic audiation, and spatial orientation. Other cognitive skills that contributed to music reading were visual perception of patterns and spatial-temporal reasoning. The ability of the brain to process the melodic and rhythmic components of music again points to the perceptual and cognitive foundation of music reading.

Perhaps the most comprehensive study on the differences in perceptual and cognitive abilities that differentiated musicians from non-musicians was the study by Helmbold, Rammsayer, & Altenmuller (2005). The authors examined the differences in a wide range of primary mental abilities and general intelligence measures of musicians and non-musicians. They replicated a smaller scale study by Brandler and Rammsayer (2003) in which researchers found that the musicians in their sample were superior in verbal memory while non-musicians were superior in reasoning; however, musicians showed more complex and diversified structure of their mental abilities compared to non-
musicians. The sample in the Helmbold, et al. (2005) study included 70 musicians with at least 10 years of music training and 70 non-musicians. Participants took a comprehensive intelligence test battery that measured verbal comprehension, word fluency, space, reasoning, number, memory, flexibility of closure, and perceptual speed. Additional tests measured logical thinking and reasoning abilities. The memory test was divided into verbal, numeric, and spatial memory. Helmbold, et al. did not find significant differences in the structure or specific aspects of mental abilities of musicians and non-musicians. Only in flexibility of closure (identifying hidden visual patterns) ($p = .05$) and perceptual speed (finding letters) ($p = .01$) did musicians perform significantly better. Additional analysis between keyboard and non-keyboard musicians did not suggest any evidence that these two abilities are a result of training. The authors suggested that differences in basic perceptual skills related to pattern recognition and processing might be prerequisites or components of musical ability. They stated:

\[\ldots\] it seems possible that these two basic perceptual abilities might represent crucial aspects of musical information processing such as rapid recognition of musical symbols or structures. \ldots\] Especially with regard to sight-reading, associations to Flexibility of Closure and Perceptual Speed might exist, as it depends on rapid processing of complex visual stimuli and precision of multimodal sensory-motor coupling. (p. 80)

The question that remained unanswered was whether the cognitive and perceptual abilities that Helmbold, et al. identified as prerequisites of music reading (pattern recognition and processing speed) are susceptible to training and can be improved through experience.

From the combination of cognitive skills involved in ISR, pattern recognition emerged as most frequently identified by researchers (Stebleton, 1987; Wolf, 1976). It
also became evident that short-term memory is an important factor for both pattern recognition (Stebleton, 1987; Wolf, 1976) and processing speed (Wolf, 1976; Helmbold, et al., 2005). While some researchers (Helmbold, et al., 2005) concluded that these perceptual abilities are prerequisites of musical ability, Stebleton (1987) suggested that both might be improved through training.

**Visual Perception in Instrumental Sight Reading**

Some researchers have recognized another perceptual skill required for successful instrumental sight reading, perceptual span, and have found that it too involves cognitive processes. Sloboda (1977) examined 6 keyboard musicians’ visual processing of phrase units in music reading. The author made the distinction between "physical" unit markers (the most obvious ones), which allow phrase boundaries to be determined without analysis of the elements of the music, and "structural" unit markers such as cadential sequences, which define a phrase based upon its internal structure. Two significant interactions emerged: structural markers x distance of critical boundary from cut-off point ($p < .025$) and physical markers x phrase length ($p < .01$). Sloboda found that the structural marker increased and caused the perceptual span to extend exactly to a phrase boundary; however, he noted that attention to physical markers and to structural markers are not mutually exclusive procedures and concluded that both physical and structural markers affect the eye-hand span in sight reading and that "awareness of structural constraints in musical text is an important component of the sight-reading process" (p. 122). Sloboda also noted that the harmonic structure aided sight readers in predicting the flow of the music in anticipation of the structural markers, as opposed to the physical
markers which did not cause the same effect. This suggested to Sloboda that the sight readers were extracting cognitive information and their eye-hand span corresponded to the structure of the music, further supporting the view that music reading is a cognitive process.

The perceptual processing of music notation was the focus of two experiments by Waters, Underwood, & Findley (1997). The participants, college students, were divided into three groups: two levels of expert musician groups (one passed Grade VIII examination on some instrument and the other passed lower grade examination) and one non-musician group. In experiment 2 the researchers examined the relationship between sight-reading expertise and the nature of their eye movements. The eye movements of the participants were recorded during a pattern-matching task. The eye-movement results from this experiment suggested that "more experienced musicians do use larger units . . . than do non-musicians and, moreover, that they take fewer fixations and require less viewing time to process those units" (p. 486). The authors found an interaction effect for expertise x temporal structure ($p < .05$), suggesting a significant difference in processing coherent and randomized material. The results did not reveal, however, whether the differences in expertise were based in perceiving the notes (encoding ability), in storing the stimuli in short-term memory (memory ability), or in comparing two structures as same or different within short-term memory. Waters, et al. (1997) noted that the causes for differences in individual sight-reading ability could be numerous because of the complex nature of the process.

Research indicates that a broad spectrum of perceptual and cognitive processes
influence instrumental sight reading ability. Among them the eye span factor and the 
ability to determine the structure of music were identified (Sloboda, 1977) and the eye 
movements were more effective for musicians than non-musicians (Waters, et al., 1997). 
The number and variety of such factors and predictors of success in instrumental sight 
reading emphasize the complex nature of the process and its reliance on diverse cognitive 
structures and abilities.

**Pattern Recognition**

Pattern recognition has been consistently identified as a cognitive process 
necessary for success in instrumental sight reading; hence, it warrants separate 
consideration. Recognizing patterns as musical structures with phrases and cadences, 
melodic contour, or interval relationships is related in concept to recognizing tonal 
patterns; however, pattern recognition is a broader skill, which would allow recognition 
of patterns in tonal music as well as in other systems. The ability to recognize patterns is 
a useful skill for both vocal and instrumental sight reading. Most of the studies on 
pattern recognition, however, have been conducted with regard to instrumental sight 
reading. In the following studies both the ability to recognize patterns and the speed with 
which skilled and unskilled musicians were able to perform pattern-recognition tasks 
were examined.

In another experiment conducted by Waters, Underwood, & Findley (1997) the 
researchers examined whether sight-reading acuity is related to the speed with which two 
notated music patterns are identified as same or different, thus testing the hypothesis that 
skilled sight reading is associated with the ability to rapidly process groups of notes.
Thirty-three university students were divided by skill level into three groups of eleven and were tested on accuracy and reaction times. There were no significant differences among the groups in accuracy, but results for reaction time and expertise were significantly different ($p < .01$). Further, the results did show that there was an interaction effect for expertise and temporal structure ($p < .01$) and that the better sight readers were significantly faster with coherent material than with randomized material. The authors concluded that randomization of rhythms may have affected musicians’ ability to chunk the material into meaningful patterns. It appeared that achievement in sight reading is supported not only by the ability to recognize patterns, but also by the ability to extract meaningful information from them, which was not possible when patterns were randomized. The researchers stated that musicians may "... use context to anticipate the continuations of musical passages, thus decreasing the information-processing load" (p. 478).

Pattern recognition appears to be a major factor in developing instrumental sight reading as evident from the Waters, et al. study. The combined results from their two experiments indicate that as a perceptual task, pattern recognition depends on eye movements while as a cognitive task it depends on identifying musical structures and extracting information from them. Sloboda (1984) also found that good sight readers are able to find higher-order structures in music that link notes together into groups or patterns.

In the previously mentioned study conducted by Wolf (1976), all of the interviewed pianists indicated that "musical sight reading was essentially a task in pattern
recognition (i.e., in recognizing familiar musical configurations on the printed page)” (p. 145). The interviewees also indicated that some factors may undermine their ability to chunk the information into familiar patterns. Among those, the randomness in some contemporary atonal compositions seemed to undermine the accuracy of predictions regarding continuation of the music and make it difficult if not impossible to find patterns. In such cases, pattern recognition skill may not be useful and other sight-reading strategies may need to be applied. Wolf added that hearing the music in sight reading facilitates evaluation regarding the accuracy of the transfer of information from eyes to the mind and fingers, regardless of the extent to which the cognitive processing and analyzing of music happens before it is played.

Waters, Townsend, & Underwood (1998) used a sample of 30 pianists to conduct seven experiments and to extend the previous research on factors that contribute to successful sight reading. Their specific goals were to find empirical evidence of the relationship between sight reading and pattern recognition and between sight reading and auditory and prediction skills. One of the purposes of Experiments 2, 3, and 4 was to extend previous research on recognizing patterns in musical information. Three pattern recognition tasks were used: note-recognition, recall, and pattern-matching tasks. In their Experiment 2 (note naming) the more skilled sight readers were faster at recognizing and processing the individual notes than the less skilled readers. During Experiment 3 (recall) better sight readers were able to recall more correct notes, and during Experiment 4 (pattern matching) the more skilled readers were able to code music in larger patterns than the less skilled readers. The correlations between sight reading and speed of pattern
matching for both same \((r = -.42)\) and different \((r = -.36)\) trials were significant at the \(p < .05\) level. The authors stated:

From a cognitive psychological perspective, sight reading can be most usefully characterized as a transcription task. . . . In transcription, material is presented in one form and the performer must rapidly realize it in some other form. . . . In this paper, we examined the 'input' skills involved in musical sight reading. . . . The fact that musicians can have similar general performance abilities ('output' skills) but vastly different sight-reading abilities ('input' + 'output' skills) implies that the attainment of input skills must be important to sight-reading facility. (p. 124)

Waters, et al. concluded that the more skilled readers in their sample of pianists were simply faster at processing and retrieving the identity of individual notes than the less skilled readers. The more skilled readers were able to utilize larger musical units and could encode music in larger chunks than the less skilled readers. They also noted that pattern-recognition skill is only part of the sight-reading skill. Other component skills involved in sight-reading ability were auditory skills and prediction skills.

There are two approaches recognized in the research literature regarding beginning instruction in music reading: note identification and tonal pattern instruction (MacKnight, 1975). It is usually implied that the tonal pattern approach is superior to note identification because it prepares the students for successful sight reading. In the Waters, et al. (1998) study, the more skilled readers were better than the less skilled in both identifying individual notes and identifying patterns. It is possible that both approaches are mutually inclusive and each contributes a unique benefit for beginning instruction in music reading.

In all of the reviewed studies the ability to recognize patterns in notated music was a strong indicator of skilled instrumental sight reading. Pattern recognition ability
was not only possible, but also faster with coherent material than with randomized
(Walters, et al., 1997; Wolf, 1976). Skilled sight readers were able to encode larger
patterns in addition to their ability to recognize individual notes (Waters, et al., 1998),
suggesting that skilled sight reading involves perceptual and cognitive skills. These
findings again reflect the complex nature of sight reading and suggest the necessity for
its development to be approached from multiple and various perspectives.

**Tonal Sense**

As indicated in the studies reviewed above, pattern recognition is one of the
primary skills necessary for successful sight reading. Experience with singing and
playing tonal patterns while performing tonal music could likely contribute to the
development of pattern recognition skill, particularly for music in a tonal framework.
Some tonal sense is developed through enculturation; however, its development can be
enhanced through a systematic method of training as is the case with *Music Learning
Theory* (Gordon, 2003 Edition). As implied by the name, the tonal patterns are present
within and useful when performing Western tonal music.

Krumhansl (1979) sought to describe the perceptual foundation and the process of
acquisition of tonal sense through examination of the psychological representation of
musical pitch in a tonal context. Participants were asked to judge the similarities
between pairs of stable or unstable tones in the context of their tonal relationships.
Krumhansl maintained that, as musical entities, tones acquire meaning through their
relationships to other tones and become part of a larger structure, such as tonality. In a
tonal system each tone serves a distinct function and some of them serve as
psychological reference points, depending upon their relationship to the tonic triad and to the diatonic scale associated with that tonal system. Music listeners perceive a pattern of relationships and form a psychological representation of tones in the tonal context. Krumhansl's results suggested that, "... in the psychological representation, tones less closely related to the tonality are less stable than tones closely related to the tonality, and that the representation incorporates the tendency for unstable tones to move toward the more stable tones in time" (p. 346). Tones less related to the tonic were perceived as less stable in the psychological representation. This suggested to Krumhansl that non-diatonic tones may be more difficult to remember in a tonal context than diatonic tones. The researcher was able to predict an interaction between the context (tonal or atonal) and the type of tone (diatonic or non-diatonic) in which diatonic tones were better remembered in tonal contexts, and non-diatonic tones were better remembered in atonal contexts. This suggests that tonal contexts selectively reinforce the representation of diatonic tones and weaken the representation of non-diatonic tones in memory. In the memory representation, non-diatonic tones exhibit a tendency to be biased toward diatonic tones, just as there is a tendency for tones in musical phrases to move from the less structurally stable tones to the more stable ones, particularly to the tonic itself. Krumhansl stated that "These results indicate the tonality-specific nature of the psychological representation and argue that the perception of music depends not only on psychoacoustic properties of the tones, but also on processes that relate the tones to one another through contact with a well-defined and complex psychological representation of musical pitch" (p. 346). It appears that such a developed sense for stable and unstable
relationships among the tones and their tendencies to gravitate toward stable ones in a musical structure could enhance the understanding and recognizing of this structure as a familiar pattern which in turn would facilitate better music reading.

**Tonal Sense in Vocal Sight Reading**

The tonal sense in vocal sight reading (referred to as sight singing) was examined by Boyle and Lucas (1990). The authors further developed the concept that "melodic expectations are a reflection of previous experiences with music based on a tonal harmonic framework" (p. 2). They studied 30 undergraduate music students’ ability to sight sing tonal melodies with and without tonal harmonic accompaniment. Students were divided into three groups based on their enrollment in first, third, or fourth semester of ear training class. A two-factor repeated-measures ANOVA test for interaction between sight-singing scores and harmonic context was significant at the .07 level, leading the authors to conclude that students scored significantly higher when the sight-singing performance was in the context of a tonal harmonic accompaniment vs. no accompaniment. The dependence on the harmonic accompaniment decreased as the level of sight-singing accuracy increased, particularly in upper level ear-training classes, who scored significantly higher than lower level classes in sight singing. The harmonic accompaniment seems to have provided the tonal support on which a developing tonal sense would need to be grounded. Once the tonal sense is established, the dependence on harmonic support seemed to decrease.

The tonal sense of experienced singers was challenged in a study by Fine, Berry, & Rosner (2006). They investigated the role of concurrent musical parts on the ability to
sing in tune and to maintain the key during sight singing and to assess the effects thereof on melodic and harmonic coherence. Twenty-two experienced singers were asked to sing four well-known Bach chorales that had undergone harmonic or melodic alteration or a combination of the two. In the harmony-altered condition, 19 participants made a transposition error (sang an initial note incorrectly but kept the relationship between next notes correct, i.e. transposed them up or down) versus only 3 in the non-altered harmony condition. The authors suggested that in the altered condition participants lost the sense for key, resting tones, and other harmonic clues. A repeated-measures ANOVA revealed a significant effect for melody ($p < .001$) and harmony ($p < .001$). Altered melodies and altered harmonies led to more sight-singing errors than non-altered. Results indicated that pattern recognition and harmonic prediction are integral to sight-singing ability. The role of internal auditory representations increased as familiarity with the music increased. The researchers stated that "...singers must create the pitch internally through subtle kinaesthetic processes" (p. 433). Because interval singing and sight singing were correlated positively, the authors concluded that "...more skilled sight singers are better at recognizing and using melodic patterns and that these abilities no doubt develop with experience" (p. 440). In regard to pattern recognition, this study is the only one identified in the research literature that mentions the role of melodic patterns in vocal sight reading.

In general, the development of a tonal sense seems to be important for both accurate singing and playing. Singers who have not developed a tonal sense could lose the tonal center, could transpose to a different tonal center, or could not maintain the interval and harmonic relationships between the tones particular to the
tonality in which they are singing (Fine, et al., 2006). Lack of tonal sense in instrumentalists may also result in an unstable intonation (MacKnight, 1975; Swindell, 1984).

**Tonal Sense in Instrumental Sight Reading**

In an early study of the development of a tonal sense during instrumental instruction, MacKnight (1975) developed and tested teaching techniques and materials that introduced music reading and emphasized the melodic phrase. The experimental group, composed of 90 fourth-grade wind instrumental students, was introduced to a series of tonal patterns presented aurally, in an auditory-visual way, and included within the context of a musical phrase. The control group learned a new pitch by letter name, fingering, and sound, known as the note-identification approach. Students were pretested on the *Music Aptitude Profile* (Gordon, 1965) and posttested on the MAT (Colwell, 1969) and the *Watkins-Farnum Performance Scale* (Watkins & Farnum, 1954). The effect of the treatment was significant ($p < .05$). "The study showed that tonal pattern instruction is superior to note identification teaching techniques in development of both sight reading skills and auditory-visual discrimination skills" (p. 23).

When a new note is presented and learned as an isolated pitch, students tend to focus on individual notes one at a time, shortening their vision span and restricting their ability to think musically about how the note fits into a pattern or tonality (MacKnight, 1975). Musical symbols and sounds are given meaning in the context of tonality and in their relationships to the resting tone and mode (MacKnight, 1975; Krumhansl, 1979). If students are taught to recognize the notes by letter name or finger number, they will
probably improve their note identification skills, but may not develop the pattern recognition skills necessary for successful ISR. In addition, if students do not place the notes in a tonal context, they may not be able to find a meaning to the patterns, even though they might be able to perceive them. The answer to Swindell's (1984) question: "If instrumental students have not developed a sense of tonality, which is a requisite for more advance work, how can they play in tune, or play meaningfully?" (pp. 7, 8) would be that without a developed tonal sense students are ignorant of the quality of their intonation. The note identification approach does not engage the higher cognitive processes needed for successful sight reading.

The intonation on any non-fixed pitch musical instrument and especially on string instruments to an extent is dependent on the technical proficiency of the player or singer. Insufficient and imprecise control of musculature that produces the sound may result in imprecise intonation. It seems that instead of relying on kinesthetic memory when playing, it is the auditory representations for pitch that should guide instrumentalists as well as singers. In such a case it can be concluded that the intonation on the instrument would reflect the accuracy of the performer's auditory representations, including the tonal sense.

Auditory Representations and Kinesthetic Memory

Gathering empirical evidence for the existence and function of auditory representations has been a challenging task for many researchers. The difficulties come from the necessity to collect objective data about mental processes, the presence of which can at best only be inferred from activities such as vocal and instrumental sight reading.
Auditory Representations

The purpose of Holahan and Saunders' (1997) study was to investigate aural perception of pitch pattern structures by second-grade students (N = 61). The authors sought to perform a systematic inquiry into contour and harmonic function content and their relationship to speed and accuracy in the aural recognition of sameness and difference in melodic patterns. The patterns were selected from the most difficult level patterns in Gordon's taxonomy, and each had either a tonic, subtonic, or dominant function. The twelve 3-tone patterns were paired and combined in different ways to account for four types of melodic contour, three types of harmonic function, and "same" or "different" patterns in one pair. The patterns were divided into two tests and some students took both tests, while others took only one. During the individual test sessions the patterns were played on a computer and students were instructed to select whether the patterns were the same or not. Depending on the number of correct responses, students were classified into high, average, or low level of achievement. Data revealed that the repetition of tonal pattern content from one testing session to the next showed improvements in speed, but not in accuracy. Students who took both tests were better at identifying "different" pairs with the same contour. There was a significant effect for achievement level (p < .001). The accuracy of recognition of tone pattern pairs with "same" items and same-contour "different" items was related to achievement level. The authors discussed the role of mental representations that are created and retained as the melodic patterns and structures are being perceived. While those mental representations are held in working memory, they are compared with mental representations of melodic
structures made familiar through experience and held in long-term memory. Holahan and Saunders concluded that perceived melodies conforming to mental representations held in long-term memory are comprehended by a listener with relative ease, explaining why the sameness of patterns is recognized more readily than difference. Familiarity with the conventions of the tonal system, therefore, would enhance the understanding of music and provide a criterion against which accuracy of the auditory representations can be evaluated and new auditory representations developed.

The process of forming auditory representations in young students seems to rely on previously learned musical structures, a process closely related to enculturation. It also appears to depend on memory processes, similar to the formation of pattern recognition skill and tonal sense. Because the development of auditory representations involves both perceptual and cognitive processes, it could be considered a learned behavior.

Wöllner, Halfpenny, Ho, & Kurosawa (2003) investigated the importance of auditory representations, which they call inner hearing, in vocal sight reading. An assumption of the study was that inner hearing is closely related to singing and plays an important role in sight singing. Participating college students (n = 20), some of whom were singers, were asked to sight sing two melodies under two performance conditions: (1) without auditory interference, and (2) with sounding music in the headphones during the one minute silent review of the melody and during the sight singing. The researchers predicted that inner hearing would be inhibited during the interference condition and that participants would make more mistakes compared to singing without interference.
Surprisingly, the difference in the mean number of mistakes between the two performing conditions was not significant \( (p = .21) \). Only the rating on "overall quality" between the two performing conditions was significant \( (p = .02) \). Participants indicated in follow-up questionnaires and interviews that the distracting music did affect their inner hearing. To overcome the distracting music, the participants had to focus better, concentrate on the intervals, or imagine playing the melodies on their instruments. Researchers concluded that participants may have been able to ignore the distracting music when they concentrated on the task and that the mental representations formed by one's own voice might be different from mental representations formed from external acoustical stimuli. Thus, through selective attention they were able to focus on the sight-singing task, and their performance was not significantly impaired.

**Notational Audiation and Priming Effect**

An area of interest to many researchers has been whether a visual score evokes auditory representations. Gromko (2004) speculated that "when skilled musicians read musical notation, they may mentally represent the sound as an image with spatial and temporal dimensions" (p.12). During this process, usually referred to as notational audiation, the auditory representations are evoked from notated music instead of sound. In the previously described study, Waters, Townsend, & Underwood (1998) allowed the possibility that auditory representations can be derived from visual perceptions and suggested two major benefits from auditory representations: (1) the ability to "prime" or to anticipate the flow of the music and (2) to self-evaluate the performance in terms of pitch and rhythm accuracy.
In the priming study (Experiment 5), Waters, et al. (1998) used a harmonic priming effect to examine whether skilled sight readers derive information about the musical context while visually processing chords. The participants (n = 19) were divided into upper and lower levels of sight reading expertise. Each participant was presented with two chords either related or harmonically distant, and asked to indicate whether they were of the same mode (major-major or minor-minor) or mixed (major-minor). The speed and accuracy of responses were used for data analysis. The main effect for trial type ($p < .01$) revealed faster responses to the major-major trials; the effect of chord relatedness was significant ($p < .01$) for the upper group of sight reading expertise. The main effect for relatedness and reaction time for slower trials approached significance ($p = .09$), and there was a weak statistical correlation between sight reading and the size of the priming effect ($r = -.32, p < .1$). The researchers concluded that there was evidence for some kind of harmonic priming effect and that good sight readers can expect or predict subsequent developments in the music based on the musical context, thus decreasing the information-processing load. This suggested that skilled sight readers derive more information and benefit from the musical context and structures than less-skilled sight readers. In their study "the more skilled readers showed evidence of priming but not the less-skilled readers" (p. 139).

Their experiment 6 (visual-auditory matching task) was designed to test the ability to derive auditory representation from notated music. Participants (n = 30) were asked to match a pattern of notated music with one of several aurally presented patterns. Sight-reading (SR) test scores were correlated with the five variables (note naming time $r$
=.52, p < .01, percent of correct notes on recall r = .64, pattern matching speed task for same trials r = -.42, p < .05, priming effect size r = -.32, p < .1, and score on visual-auditory matching r = .52, p < .01. A strong correlation was found between SR/percent of correct recall on recall task, (r = .64) and SR/visual-auditory matching task (r = .52). The authors assumed that the visual patterns were converted into auditory images, and they claimed that "as regards the facility to use auditory representations, we documented a strong relationship between sight-reading skill and performance in the visual-auditory matching task. . . . This is the first study to demonstrate a relationship between sight-reading skill and auditory facility" (p. 144). The better readers in this study were able to more accurately match visual patterns to their auditory versions; however, they were uncertain whether auditory representations are converted into "motoric" representations, also known as kinesthetetic imagery. The authors concluded that "skilled sight reading is associated with an ability to convert a visual representation of musical structure into an auditory representation" (p. 141). In the hierarchical multiple regression analysis at the conclusion of all experiments, the three pattern recognition measures (recall, note-naming, and speed of pattern matching) were entered together and produced a significant regression R of .45, (p < .01). When performance on the visual-auditory task was entered, it accounted for 8 percent of the proportion variance explained. Finally, the prime size on the priming task added 7 percent to the variance explained. The authors concluded that the sight-reading skill was predicted from pattern-recognition performance, auditory performance, and priming performance. Waters, et al. were able to relate sight-reading expertise to pattern-recognition skills (short-term memory), to
prediction skills (long-term memory), and to the facility to generate auditory representations.

The goal of the study was to determine whether the different component skills contribute unique variance to the prediction of sight-reading skill. The researchers claimed that auditory skills might be more important than pattern-recognition skills for successful sight reading. As the authors stated, "auditory skills and prediction skills are important factors underlying skilled sight reading over and above basic pattern-recognition skills" (p. 145). Their findings were in agreement with Karpinski's (2000) belief that "proficient readers scan ahead, taking in musically meaningful groups of notes and hearing them internally before producing their sounds" (p. 156).

Similar findings were obtained in a study by Kopiez and Lee (2008). The authors assumed that auditory imagery from notation can generate the priming effect, therefore making sight reading a question of eye-ear-hand coordination, instead of the commonly stated eye-hand coordination. Kopiez and Lee suggested that "due to higher demands in intonation sensitivity, for violinists or singers the variable inner hearing could be much more important than for pianists" (p. 56).

The results of an earlier study by Kopiez and Lee (2006) examining the significance of different predictors at five different levels of instrumental sight-reading complexity indicated that inner hearing was among the four most significant predictors. In the correlation analysis it appeared to be significant for levels 2-5. A possible explanation for lack of significance at the lowest level could be the relatively easy playing material, for which acquired technical skills might be sufficient. As the
complexity of sight-reading material increased, so did the importance of inner hearing; however, as they suggested, "due to the lack of time to create an auditory image of highly complex music, the importance of this predictor decreases from level 4 to level 5" (p. 116). The authors claimed that "for the first time, we found evidence that the skill of imagining the sound of a score can also be of advantage in sight-reading. . . . If inner hearing is successful, it can improve sight reading" (pp. 115, 116).

**Notational Audiation and Kinesthetic Responses**

The following studies show a connection between auditory representations and kinesthetic-like processes, either phonatory or manual, and point to the role of kinesthetic memory in the development and functioning of auditory representations. Brodsky, Henik, Rubenstein, & Zorman (2003) developed a study to collect empirical evidence for the concept of notational audiation. In their study, using 18 expert musicians, a well-known theme was visually disguised by embedding it into an embellished melody. The task was to recognize the theme while reading the notation silently. Participants were required to (1) read silently a score of an original well-known melody, (2) read silently a score with the well-known tune embedded within the embellished melody, and (3) listen to a melody and respond whether it is the well-known embedded tune or not.

In Experiment 1 three different reading conditions were used – a non-distracted condition and two interfering conditions: (1) rhythmic distraction (tapping a steady beat while hearing an irrelevant rhythm), and (2) phonatory interference (wordless singing or humming aloud a song). The results of Experiment 1 demonstrated that when reading music notation silently, expert musicians performed worse in recognizing themes
embedded into embellished phrases when they were distracted by rhythm distraction and phonatory activity (singing a song), but the phonatory interference resulted in greater impairment. A repeated-measures ANOVA revealed significant differences in response times between the conditions ($p < .01$), which were longest in the phonatory interference condition. Significant differences existed between the reading conditions and the number of correct responses ($p < .0001$); the most correct responses were found in the non-distracted condition, and the fewest correct responses were between the non-distracted and phonatory-distraction conditions. The results suggested that the auditory imagery triggered by musical notation elicits kinesthetic-like phonatory processes. The researchers suggested that "engagement in phonatory activity was the source of interference with notational audiation" (p. 608). The researchers concluded that the phonatory interference specifically impeded music comprehension. Comprehension was most impaired when articulation was not possible during phonatory interference. The authors proposed that "notational audiation is the silent reading of musical notation resulting in auditory imagery involving kinesthetic-like phonatory processes" (p. 610). Because of the nature of the process of notational audiation and the involvement of kinesthetic-like phonatory processes, Brodsky, et al. (2003) suggested that notational audiation may be a skill linked more to inner voice than to inner ear.

Kinesthetic-like phonatory processes appear to be similar to the concept of subvocalization advanced by Klonoski and Johnson (2003) in which the vocal apparatus is engaged without producing actual sound. The findings from this study provide empirical evidence for the suggestions made by Klonoski and Johnson (2003) that the
role of subvocalization is to provide a bridge between inner voice and physical voice, which seem to be closely interconnected. Singing, whether silent or not, develops auditory representations through linking the imaginary sound to the produced one. The phonatory system serves the purpose of providing the brain with the information needed in order to give the right command to the proper muscles at the proper moment. If the brain does not receive the necessary information, phonation frequency is not adjusted with precision. This causes instability in intonation or even singing off pitch (Sundberg, 1984). The two types of singing, silent and aloud, however, have the same origin, i.e., the brain with its perceptual and cognitive abilities.

A more recent study by Brodsky, Kessler, Rubenstein, Ginsborg, & Henik (2008) further explored the phonatory nature of notational audiation with throat-audio and larynx-electromyography measurement during a similar embedded-melody recognition task. The researchers examined the reliance on phonatory and manual motor processing used during music reading and suggested that notational audiation elicits kinesthetic-like covert phonatory processes such as silent singing. They similarly concluded that "the mind's representation of music notation might not have anything at all to do with hearing per se" (p. 428).

An additional finding of their (Brodsky, et al., 2008) research was that silent reading of music notation involves actual motor processing systems, and mental representation of music notation involves both articulatory and manual motor imagery. The authors concluded that . . . a reliance on manual motor imagery is inevitable because of the closely knit cognitive relationship between reading music and the associated manual gestures
imprinted in the minds of music readers by having a music instrument in hand. . . . (pp. 437, 438). . . . We therefore conclude that both kinesthetic-like covert excitation of the vocal folds and concurrently cued manual motor imagery are equally vital components that operate as requisite codependent cognitive strategies toward the interpretation and/or judgment of the visual score – a skill referred to as notational audiation. (p. 443)

The researchers extended the concept of auditory representations involving kinesthetic processes ranging from silent singing to manual motor actions. Their conclusions clearly point to the role of kinesthetic memory during both silent and actual playing and silent and actual singing for development of auditory representations. While for some students playing the instrument may be sufficient for development of accurate auditory representations, adding the benefits from vocal kinesthetic memory may be necessary for others. In contrast to vocal students, instrumental students have the opportunity to use both instrumental and vocal kinesthetic memory to develop auditory representations.

Butler (1997) also suggested that performance and listening are related through physical motion. Motions learned in instrumental music performance contribute to development of kinesthetic memory that in turn assists in the development of the ability to generate and control a mental image of music. "Motion," Butler wrote, "may be a physical/physiological accompaniment to skilled analytical listening" (p. 46). For Butler, kinesthetic processes are a basis for development of auditory representations. The auditory representations evoked through kinesthetic motion seem to be a shared phenomenon that provides a connection between vocal and instrumental sight reading.
Additional Factors in Development of VSR and ISR

Pitch Matching and Accuracy

Pitch matching and pitch accuracy are important skills for VSR and ISR alike; however, most studies on pitch appear to focus primarily on vocal pitch matching and accuracy. Methods for their improvement have been studied and compared to the skill of singing a complete song, but the two skills are considered by researchers to involve different perceptual and cognitive processes. A study by Cassidy (1993) used different sight-singing strategies to determine whether improvement in sight singing would transfer to improved pitch accuracy while singing a familiar children's song. The treatment conditions were (1) training with solfege syllables while using Curwen hand signs, (2) singing with solfege syllables only, (3) singing with letter names, and (4) singing with a neutral syllable. College students (N = 91) majoring in education were divided into four treatment groups plus one control group. On the posttest all experimental groups showed improvement in sight singing, although significant differences were found among the five groups (p < .001); however, there were no significant differences among the groups on the task involving singing a familiar song (p > .05). Apparently, the accuracy in sight singing did not transfer into pitch accuracy while singing a familiar song. The results suggest that VSR and singing a familiar song are different behaviors that draw on different performance competencies. Singing songs alone may not serve as a tool for developing VSR; therefore, it appears that improvement in VSR would have to be achieved through focusing on the particular competencies necessary for that skill.
Similar results were obtained in a study by Guerrini (2006) who investigated variations in vocal accuracy of fourth- and fifth-grade students when singing (1) eight patterns consisting of three notes each, (2) a long-familiar song, and (3) a newly-learned song. Results indicated that the singing of patterns was significantly more accurate than singing either a familiar or a newly-learned song. The data suggest that students acquire proficiency in singing patterns before they acquire proficiency in singing songs. The author offered the explanation that echo-singing patterns does not require the deeper audiation skills, such as tonal memory, that is necessary for singing a full song.

The following study (Mang, 2007) compared the pitch matching abilities of instrumental and choral students and musically trained and untrained students. Mang investigated the song performance and melodic pitch matching skills of seventy-five university students in Hong Kong. They were divided into three groups depending on their type and level of music background. The first group consisted of instrumentalists who had formal music training but little choral experience, the second group comprised choristers who did not have music training but had substantial choral experience, and a third, the control group, consisted of musically untrained and inexperienced college students. Results suggested that choral experience and formal instrumental music training had different effects on pitch-matching and song-performance tasks. Instrumentalists performed significantly better on a pitch-matching task, and the group with choral experience performed significantly better in song performance tasks. The researcher confirmed previous suggestions that pitch matching and song performance are different and independent competencies and may be viewed as complex hierarchical
auditory processing tasks. The cognitive load for auditory imagery in a pitch-matching task would be relatively low, because it does not require melodic retrieval from long-term memory. In contrast, in a song performance task familiar melodic material is retrieved from long-term memory, and a feedback system is necessary to monitor the tonality and the accuracy of sung pitches against target ones. "The instrumentalists undoubtedly possessed more sophisticated mental skills for music processing but evidence tends to suggest that singing a song requires coordinated use of singing skills, which integrate sensory perception with motor planning and execution" (Mang, 2007, p. 88).

Instrumental students usually have experience with pitch discrimination and pitch matching, especially if they have been taught the note identification approach, i.e., learning the notes one at a time; however, if the auditory representations, sense for tonality, and long-term memory are better developed through singing complete musical entities, such as songs or instrumental pieces, then it would be beneficial for instrumental students to engage in such activities.

Watts, Moore, and McCaghren (2005) also concluded that the process of vocally matching the pitch of a target tone is different from that of singing a melody. The purpose of their study was to measure $F_o$ (fundamental frequency) control with a vocal pitch-matching task and to determine whether accurate singers have more refined $F_o$ control abilities and more accurate pitch discrimination abilities than inaccurate singers. They maintain that pitch is a psychological phenomenon, but they defined intonation accuracy as "the perceptual impression of singing in tune, in which adjacent notes were in correct relationship with each other" (p.536).
To accurately match a target frequency, a person must use sensory abilities, via the auditory system in the context of pitch perception, and motor abilities that coordinate the subsystems of speech (respiration, phonation, vocal tract resonance) to reproduce the perceived pitch. (Watts, Moore, & McCaghren, 2005, pp. 534, 535)

Monitoring vocal F₀, therefore, consists of ongoing auditory assessment of the accuracy of perceived pitch and corresponding adjustments in the vocal apparatus in order to produce the intended F₀. The authors found a significant relationship between pitch discrimination and pitch matching, and they concluded that increased pitch discrimination accuracy usually yielded more accurate pitch-matching abilities. The main effect for pitch was significant \[ F = 7.40, p = .01 \]. Results suggested that untrained accurate singers had more precise pitch-matching and pitch-discrimination skills than the inaccurate singers. "In a pitch-matching task, one must accurately perceive the pitch of the target tone before programming motor neurons for reproduction of the stimulus. . . . [P]ersons who have difficulty hearing pitch differences will also have difficulty with intonation accuracy. . . "(p. 540). The conclusion was that both accurate perceptual abilities and precise vocal control are necessary for accurate singing.

Several conclusions can be drawn from these studies. It appears that pitch discrimination and pitch matching are related skills, but pitch matching and pitch accuracy in singing a song are different abilities. Song singing was better developed in choir participants in contrast to students not involved in singing activities. Possible reasons could be experience in retrieving music material from long-term memory, and the contribution of a strong sense of tonality, which is necessary for pitch accuracy when singing a song. These suggestions approximate Wolf's (1976) position that reliance on
different memory storage systems results in difference between skilled instrumental performers and skilled sight readers. Compared to the distinction between vocal pitch matching and singing a song, reliance on different memory storage systems appears to be a common cognitive process.

**Melodic Dictation and Error Detection**

The following studies examined the relationship between different components of aural skills training, namely vocal sight reading, melodic dictation, and error detection. In essence, they revealed that the components of aural training are related and that improvement in one of them is likely to lead to improvement in others.

The relationship between sight singing and melodic dictation of university music students majoring in music (N = 41) was the topic of a study by Norris (2003). Another concern was whether the relationship would change as a result of instruction in both sight singing and melodic dictation. The researcher found that after a semester of instruction, both sight-singing and melodic-dictation accuracy improved significantly ($p < .001$). There was a moderately strong statistically significant ($p < .001$) correlation between pretest sight singing and pretest melodic dictation scores ($r = .62$), and between posttest sight-singing and posttest melodic-dictation scores ($r = .57$). Although the scores changed significantly from pretest to posttest in both skills, there were essentially the same moderately strong correlations between the skills at the beginning and at the end of the semester. Norris concluded that it is likely that sight-singing and melodic-dictation skills are related and that incorporating melodic dictation into sight-singing instruction may improve student achievement.
Larson (1977) examined undergraduate music majors' (N = 90) levels of competency in error detection, melodic dictation, and sight singing, and the relationships among them. The author stated that "the study was based on the premise that one of the most important skills for success in music teaching is the ability to identify errors in student performance" (p. 264). The melodies for the aural tasks were classified as tonal, diatonic, chromatic, or atonal. While an ANOVA revealed significant ($p < .0001$) differences among different aural tasks and melodic styles, the correlation between tonal error detection and dictation was strong, ($r = .80, p < .05$) and between error detection and sight singing moderately strong, ($r = .62, p < .05$). Larson made the suggestion that aural training needs to include experience in error detection. Music dictation, error detection, and vocal/instrumental sight reading are aural skills that share some common processes. It is possible that development of one could lead to improvement in the others.

**Playing by Ear**

Playing by ear is a type of aural skill that helps develop auditory representations through the use of an instrument. Several authors supported the inclusion of playing by ear in instrumental classes. McPherson (1993) studied high school instrumentalists (N = 101) to test a theoretical model of a "balanced" approach to instrumental training involving five interconnected music performance skills: performing rehearsed music, sight reading, playing from memory, playing by ear, and improvising. The subjects were tested on each of the five variables. The assumption underlying the theoretical model was that performing and improvising abilities would be related to the abilities to sight
read, play from memory and play by ear. A strong correlation was found between playing by ear and improvising ($r = .77$) and between sight reading and improvising ($r = .75$); all of the variables were moderately correlated with the ability to play from memory. The relationship between the ability to play by ear and sight reading was moderate ($r = .40$) for less experienced musicians and stronger ($r = .55$) for more experienced, suggesting that both subskills were improving as the instrumentalists matured.

Luce (1965) also tested high school students ($N = 98$) in sight reading and in playing by ear and determined that there was a positive relationship ($r = .50$) between sight reading and ability to reproduce melody by ear. Luce found the relationship between ear playing and total hours of music instruction to be stronger than the relationship between sight reading and total hours of music instruction and suggested that ear playing might be more responsive to training than sight reading ($\text{total hours/SR}, r = .24; \text{total hours/EP}, r = .36, p = .05$). The author stated:

> If ear-playing is a skill that can and should be developed through teaching, new approaches to teaching ear-training must be determined. The importance of the ear in musical performance indicates that ear-playing may possibly be more important in developing musicianship than sight-reading. (p. 107)

Luce apparently supported the idea that these subskills (sight reading and playing by ear) are learned behaviors. Because playing by ear engages aural skills to a greater extent than sight reading does, total hours of instruction may have contributed to improvement in aural skills, thus resulting in a stronger correlation with playing by ear than with sight reading.

It appears from these studies that playing by ear does not impede performance
skills and that it is positively related to instrumental sight reading, improvising, and playing from memory. Moreover, playing by ear has been shown to benefit students' musical development. Because playing by ear means a conversion of sounds into kinesthetic actions, it requires some proficiency in manipulating the instrument and it should be used in accordance with the level of technical development of instrumental students. Playing by ear is closely related to melodic dictation (which involves converting sounds into symbols). Consequently, if students have developed some notational skills, playing by ear and melodic dictation could be complementary activities and strong tools for developing a cognitive understanding of music.

**Relationship between Vocal and Instrumental Sight Reading**

Only one study was identified that examined the relationship between vocal sight reading and instrumental sight reading, as well as their relationships to several other variables. Elliott (1982) tested 32 wind instrumentalists from undergraduate music theory classes on the *Watkins-Farnum Performance Scale* (Watkins & Farnum, 1954), the *Technical Proficiency Evaluation*, and *Criterion Sightsinging Test* (Thostenson, 1970) in order to investigate the relationships among instrumental sight-reading ability and seven selected variables: (1) technical proficiency, (2) rhythm-reading ability, (3) sight-singing ability, (4) cumulative grade point average, (5) cumulative music theory grade point average, (6) cumulative performance jury grade point average, and (7) major instrument grade point average. Elliott completed multiple correlations to determine the relationships among all of the variables and found that the strongest single relationship was between the Watkins-Farnum scores and the Rhythm Reading scores from the CSST
(r = .90) (p value not included). Additional analyses were conducted using the General Linear Model to determine the amount of variance that each variable contributed to the sight-reading scores. In this model rhythm-reading and performance jury scores accounted for 88% of the variance in the sight-reading scores. Elliott concluded that "rhythm-reading ability and performance jury scores combine to make the best predictors of wind instrumentalists' sight-reading performance scores" (p. 13).

This study was the only one identified in the research literature that tested the relationship between VSR and ISR of instrumentalists. Elliott found the relationship between sight reading and sight singing to be moderate (r = .59) (p value not included) and the amount of variance that sight singing contributed to the total variance was -0. 57 (p = .57). In this study students' sight-singing scores were not predictors of their sight-reading performance, suggesting that sight singing and sight reading may be different competencies. Thus, competence in one skill does not necessarily imply competence in the other.

**Vocal Sight Reading and Instrumental Experience**

Many studies of vocal sight reading revealed that instrumental experience plays some role in determining success in VSR. The studies reviewed in this section use both terms, sight singing and sight reading, to denote vocal sight reading. Demorest's (2001) review of the research on factors that contribute to sight-singing achievement suggested that there is a relationship between achievement in sight singing and instrumental experience. The author observed that "instrumental experience was related to better sight-singing performance more often than choral experience in many studies" (p. 33).
He found that in most of the reviewed studies instrumental students were also singing in a choir, therefore developing their aural skills through both vocal and instrumental sight reading. Demorest suggested the possibility that the combination of experiences was important, not just the instrumental or choral experience alone. Additionally, the author noted that in the studies examining the relationship between sight singing and instrumental experience, piano training was most consistently related to sight-singing achievement.

In a survey by Daniels (1986) instrumental experience was again a factor for success in vocal sight reading. The author investigated 20 senior high school choirs for relationships between sight-reading ability and selected factors pertaining to the school, the music curriculum, the chorus teacher, and the students. Among the factors that appeared to contribute to successful sight reading were (1) a large percentage of choir students had a piano in their home, (2) a large percentage of choir students participated in all-state chorus, and (3) a large proportion of choir students also had experience playing a musical instrument. Factors relating to the chorus curriculum, such as using sight-singing materials or sight singing from the choral repertoire, were less important influences on students' achievement in vocal sight reading than a chorus teacher for whom development of vocal sight-reading ability was an important objective; thus, practicing sight singing on a more regular basis was important for the development of sight-singing skills.

A review of the research regarding the nature and effectiveness of teaching sight singing in high school choral programs since the 1950's was the objective of a study by Dwiggins (1984). Among the factors identified in the studies related to sight-singing
ability were many aural skills such as perception of tonal and rhythmic patterns, melodic memory, and pitch discrimination. The author mentioned that "tonal imagery is an attribute which has been found by many researchers to be highly correlated with music reading ability" (p. 9). Other studies pointed to the importance of consistency in practicing sight singing. It appears that the development of aural skills contributes to sight-singing achievement, and conversely, practicing sight singing improves the aural skills. As with previously mentioned researchers, Dwiggins also found in the reviewed research indications of a strong relationship between sight-singing ability and instrumental training. Specifically, at least six years of piano along with other instrumental and vocal experience were most likely to be related to proficiency in sight singing.

Demorest and May (1995) examined individual sight-singing skills of high school choir members (n = 414) in relation to their private musical training, their choral experience, the difficulty of the melodic material, and the system used for group sight-singing instruction. The researchers used two sight-singing melodies with different difficulty levels, which were randomly assigned to the students. Their performances were tape-recorded and scored by two judges. Demorest and May used zero-order correlation coefficients and multiple-regression analysis to examine the power of the variables in predicting sight-singing achievement. The correlations between sight-singing scores and four of the background variables (years of school choral experience, years of piano experience, years of private voice lessons, and years of outside choral experience) were all significant (p < .01). The best predictors of individual sight-singing
achievement were the number of years of school choir experience, followed by years of piano, instrumental, and vocal lessons. Interestingly, the extent of instruction on instruments other than piano and voice were important to increased sight-singing skill only when taken with piano and/or voice lessons. As the authors stated,

An issue unresolved by the present study was the effect of instrumental training on vocal sight-singing skill. . . . [Y]ears of private instrumental instruction was found to be a significant background variable in sight-singing skill development, but to a lesser degree than years of school choral experience. Individually, instrumental experience in a student's background did not predict sight-singing achievement well. (p. 164)

This study, although involving choral students, suggests that instrumental training alone was insufficient for developing sight-singing skills. Singing experience was a stronger factor than instrumental experience in predicting success in sight singing.

Research regarding the role of instrumental training on sight singing has yielded conflicting results. While in some studies instrumental experience was a strong factor for achievement in VSR (Daniels, 1986; Demorest, 2001), others included it as a predictor only in connection with piano training (Demorest & May, 1995; Dwiggins, 1984). In only one study was vocal experience more important for achievement in sight singing than instrumental experience (Demorest & May, 1995). Obviously, more research is necessary to clarify the relationship between vocal sight reading and instrumental training.

**Summary**

Most of the studies reviewed suggest that aural skills are important for developing musicianship; however, the studies also revealed the complex nature of the various aural skills and their reliance on perceptual and cognitive abilities. Conversely, the
development of cognitive and perceptual abilities in music was evaluated through success in measurable activities using different types of aural skills. Many authors were concerned with the development, relationship, and interconnectedness among various aural skills, such as vocal sight reading, instrumental sight reading, playing by ear, and taking music dictation, to name a few. The commonalities among the various aural skills rest upon the shared underlying perceptual and cognitive processes involved in understanding and communicating through music; however, researchers seemed to focus on different underlying processes and aural skills when examining VSR or ISR.

The skill most consistently identified as responsible for success in music reading was pattern recognition. Helmbold, et al. (2005) noted that the differences in perceptual skills specifically related to pattern recognition might also be responsible for differences in sight reading potential. Other aspects of pattern-recognition skill were the efficiency of eye movements during sight reading and visual processing of phrase structures (Sloboda, 1977) and the speed of processing visual stimuli (Waters, et al., 1997). These aspects of pattern-recognition skill are also related to eye-hand span and coordination, thus pointing to the kinesthetic aspects of sight-reading competency.

Pattern-recognition and motor-processing skills were mostly a concern to researchers who studied instrumental sight reading, although the importance of these skills to vocal sight reading could be inferred (Fine, Berry, & Rosner, 2006). Some authors (Waters, et al., 1998) considered pattern-recognition skill to be related to the ability to form auditory representations from notated music and priming skills. The last two cognitive skills have both been explored with regard to VSR and ISR.
Most of the research on auditory representations has been conducted in terms of notational audiation, i.e. auditory representations formed while viewing notated music. In the studies cited herein, researchers concluded that good sight readers not only form auditory representations from notated music, but also are able to predict the subsequent flow of the music (Waters, Townsend, & Underwood, 1998; Kopiez & Lee, 2006, 2008). The basis for this priming effect is most likely found in the context of the music. If the music is tonal, then a developed tonal sense would play a role in notational audiation in addition to the ability to recognize patterns from notated music. The studies showed that good sight readers utilize auditory representations while using tonal sense and pattern-recognition skills to form predictions about the flow of the music (Waters, Townsend, & Underwood, 1998).

In the studies on notational audiation with kinesthetic responses, the kinesthetic responses were either phonatory or involved manual motor processes. It was evident that the phonatory process, i.e. silent singing, aided the formation of auditory representations during silent reading of music notation (Brodsky, Kessler, Rubinstein, Ginsborg, & Henik, 2008). These conclusions point to the role of the voice as a likely fundamental means for both developing and utilizing auditory representations. It also appears that singing is a suitable medium for developing auditory representations because of the covert and overt phonatory processes involved in it. This points to the value of vocal sight reading as a separate competency and leads to the suggestion that VSR and ISR may be mutually complementary instead of mutually inclusive competencies. Because the high intonation demands for string players necessitate well-developed intonation
control skills, the present study was designed to investigate the role of auditory
representations for pitch of string players through activities such as vocal and
instrumental sight reading to assess the development of their aural skills.

The processes underlying the formation and utilization of auditory representations
are certainly complex, but continuing research will likely increase the understanding of
them. It is apparent from the reviewed studies that the use of the voice is a contributing
factor for the formation of auditory representations. If, as evident from the reviewed
studies, the auditory representations play a role in VSR and ISR processes, then methods
such as singing that develop the auditory representations could be included in
instrumental instruction.

It seems that the focus of research on factors that contribute to the development of
VSR and ISR has varied, depending on which medium was being examined. Researchers
studying vocal sight reading were concerned with pitch matching and accuracy and the
cognitive processes involved in singing a complete musical entity such as a song. The
relationships between error detection, melodic dictation, and sight singing were examined
mostly in studies on instrumental sight reading. Playing by ear, performance on an
instrument, and improvisation were identified as factors influencing success in ISR;
however, instrumental students' vocal sight-reading skills were identified as an area in
need of exploring. Only one study included VSR and ISR of instrumentalists among
other variables, and there was a moderate but not significant correlation between them
(Elliott, 1982). None of the studies looked specifically for a relationship between vocal
sight reading and instrumental sight reading. In addition, many studies on VSR indicated
a relationship between vocal sight reading and instrumental experience, specifically piano.

Several trends in the development of aural skills were identified as a result of the review of the research:

1. Vocal sight reading and instrumental sight reading share not only cognitive but also kinesthetic processes, although the processes differ in nature.

2. Singing and vocalizing are important means for developing aural skills and forming auditory representations from notated music.

3. Auditory representations and tonal sense play substantial roles in VSR and ISR accuracy.

Very few of the studies involved orchestra students, and no study was identified that addressed its findings to string instruction. The present study responds to a need in the literature for research examining and comparing vocal sight reading with instrumental sight reading and looking for growth of those behaviors in string players.
CHAPTER 3
DESIGN AND METHODOLOGY

Restatement of Purpose

The purposes of this study were to (1) investigate the vocal and instrumental sight reading of 7th, 9th, and 11th grade orchestra students, (2) examine the relationship between vocal sight-reading and instrumental sight-reading abilities within each grade level and the overall relationship between VSR and ISR of string orchestra players in order to look for growth in these abilities and to examine the extent to which they facilitate the development of aural representations for pitch. Additional purposes were to determine whether piano experience is related to differences in VSR and ISR abilities at the respective grade levels and to examine the relationship between VSR and ISR based on students’ years of piano experience.

The following primary questions were addressed:

1. Are there significant differences among 7th, 9th, and 11th grade string instrumental students in vocal sight reading?

2. Are there significant differences among 7th, 9th, and 11th grade string instrumental students in instrumental sight reading?

3. Is there a relationship between VSR and ISR overall and at each grade level?

The following ancillary questions were addressed:

1. Are there significant differences in VSR and ISR between students who have piano experience and those who do not?
2. Is there a relationship between VSR and ISR skills of students with piano experience and those without piano experience?

**Research Instruments**

**Vocal Sight-Reading Instrument**

There are few vocal sight-reading tests readily available for the research community, but two tests were taken under consideration: the *Criterion Sightsinging Test* (CSS76) (Thostenson, 1967) and the *Vocal Sight Reading Inventory* (VSRI) (Henry, 1999).

Thostenson's objective was to develop music dictation and sight-singing tests that were compatible with each other so that the dictation test might eventually serve as an adequate measure of sight-singing achievement (Thostenson, 1967). Thostenson's premise for this test was that "a musician should have awareness of the relationship between sounded pitch and its notational representation, sounded rhythm and its notational representation, and sounded melody as pitch and rhythm combined, and its notational representation" (p.16). Thus, whether the test is used to assess sight singing or dictation, it would also provide a measure of underlying auditory representations for pitch and rhythm.

The sight-singing test consisted of separate sections for intervals, pitch phrases, rhythm phrases, and melodic phrases. Thostenson commented on his test:

> Since the sightsinging test was comprehensive, individually administered, and was designed to measure a skill whose possession is quite generally accepted as one indication of functional musicianship, this 76 item test was designated as the CSS76 Criterion Sightsinging Test. (p. 15)
Thostenson reported total test reliability for CSS76 of about .95, with reliabilities for the various sections as follows: interval .84, pitch .93, rhythm .82, and melody .92. Only the pitch phrases and melody phrases sections would have been appropriate to use in this study because those were the skills under investigation; however, the pitch phrases did not constitute a complete melody with a discernible tonal center. The sense of a resting tone is an important component of aural skills (Conway, 2003), and melodies that lack resting tones would impose additional difficulty for the students. The melody phrases section of the test combined melody with rhythm and therefore would not serve the purposes of the present study in which only pitch skills were examined. In addition, some recent neurological research suggests that melody and rhythm are processed in different areas of the brain (Thompson, 2009). Because the present study focused only on pitch assessment during vocal sight reading, I decided that the rhythm component would impose an additional burden on students and sidetrack them from focusing on pitch. Therefore, the CSS76 test was not selected for use in the present study.

The test instrument I chose to measure the vocal sight reading in the present study was the *Vocal Sight-Reading Inventory* (VSRI) (Henry, 1999). The VSRI was developed to assess the individual sight-singing accuracy of secondary-level choir singers. Henry tested 322 students in 7th through 12th grades. The test design was based on several considerations. First, it is criterion-based. As such, it provides a 28-component vocal sight-reading inventory and establishes levels of difficulty. Second, it assesses pitch skills only. Third, the test is founded on the research findings that vocal sight-reading examples need to be grounded in a tonal context; therefore, the items constitute entire
melodies in major keys. Fourth, tonal patterns representative of vocal sight-reading skills are embedded within the melodies. Henry wrote, "Vocal sight readers must have a strong grasp of the tonal framework and function of tonal elements to assist them in locating pitches" (1999, p. 14).

Henry developed two parallel forms of the VSRI. Each form contained eight exercises in which pitch skills progressed from easy to more difficult toward the end of the melody. Henry performed a t-test on the respondents' scores on the two test forms that revealed no significant differences between scores on the two versions ($p < .62$). Multiple scoring systems reliability was established through the use of two different scoring methods. With the first system only pitches that were part of any of the 28 component skills included in the inventory were scored; the second scoring system used a note-by-note approach. Henry found a correlation between the two scoring systems of $r = .96$. Using the component skill scoring system, a correlation of $r = .97$ was obtained between the two judges. Finally, an item-total correlation was performed and resulted in positive correlations ranging from .50 to .77 among the test items of the VSRI.

At the conclusion of the study Henry created two revised versions of the test in different formats. In Form A (Appendix A\textsuperscript{1}) pitch skills in ascending order of difficulty are separated into three sections with three melodies in each section. Students who had difficulty sight singing the melodies in one section did not need to continue to the next section. This form tested students' general vocal sight-reading ability. The second

\textsuperscript{1} From The development of an individual vocal sight-reading inventory (p. 196). by M. Henry, 1999, PhD Dissertation, University of Minnesota. Copyright Michele Henry (1999). Used with permission.
version, Form B, contains six melodies including all 28 component skills, in ascending order of difficulty; it is more comprehensive and all six melodies need to be completed. For the purposes of my study I selected the revised Form A because it would not require the participants to sing beyond their vocal sight-reading level. The test items in Form A of the VSRI are either in C Major, D Major, or F Major. With permission of the developer of the VSRI, I transposed all items to D Major (Appendix B²) because the test was to be given to string students who, since the beginning of their instruction on string instruments, were most familiar with reading music in D Major. Using a familiar key for the VSR test in the present study constituted an effort to assist string students in their vocal sight reading.

I identified several studies that utilized the VSRI. A study by Killian and Henry (2005) examined the strategies that less-accurate sight singers acquire and use during sight singing. The two melodies designed to test sight-singing skills were based on the compositional and scoring guidelines of VSRI (Henry, 1999) and the Texas All-State Choir audition process. Because the original VSRI measures only pitch accuracy, the researchers added rhythm tasks designed in the same manner as the pitch tasks. Killian and Henry identified the effective strategies and behaviors the accurate sight singers use and scored only these targeted behaviors during sight-singing tests. The overall inter-judge reliability between the two researchers ranged from .78 to .91. In addition, the two researchers had 26% of all participants’ recordings scored by an independent observer.

² From The development of an individual vocal sight-reading inventory (p. 196) by M. Henry, 1999, PhD Dissertation, University of Minnesota. Copyright Michele Henry (1999). Adapted with permission.
This observer found that the interscorer reliability of the two researchers was .93.

In another study using the VSRI (Henry, 2004), selected pitch skills were taught by emphasizing scale degrees and harmonic function, much in the manner in which the melodies comprising the VSRI were constructed. Scores were based on the number of pitches sung correctly. The interscorer reliability was .97, thus showing the adaptability of the scale to different research designs and purposes.

I chose the VSRI as the most appropriate vocal sight-reading instrument for the present study for several reasons: (1) It measures only pitch skills. For students who were untrained in VSR, adding a rhythm to an already complex task of singing from notation would have distorted their focus on pitch by adding another dimension to the task. (2) Items constitute complete melodies with tonal centers; therefore any developed tonal sense in students would have assisted them in performing the task (Henry, 1999). (3) The reliability and validity of the test were established and adequate.

**Instrumental Sight-Reading Instrument**

I identified two string performance scales that might meet the research objective of measuring sight-reading performance on string instruments, namely *The Farnum String Scale: A Performance Scale for All String Instruments* (Farnum, 1969) and *String Performance Rating Scale* (Zdzinski & Barnes, 2002).

Colwell (1970) and Boyle and Radocy (1987) noted that *The Farnum String Scale* had been adapted from the *Watkins and Farnum Performance Scale: A Performance Scale for All Band Instruments* (1954). The string scale uses the same type of errors (pitch, time, change of time, expression, and articulation with the addition of string
bowings) and scoring rules (a measure is the scoring unit and each measure may receive one error) as the performance scale for band instruments. The exercises progress in difficulty and a student is stopped when he/she receives a zero score in two consecutive exercises. A drawback of the two scales (band and strings) is their unsuitability for measuring intonation problems, tone quality, or interpretation. In addition, scoring items such as string bowings would not have been possible to be evaluated from a recording of the performance without actually observing the performer as was the case in this study.

Boyle and Radocy (1987) reported that, while the reliability of the band scale is high, no reliability and validity information is reported in the string scale manual and therefore the validity of the string scale is questionable. I decided that a testing instrument without established reliability and validity information would not be appropriate for the present research project.

Zdzinski and Barnes (2002) sought to develop a valid and reliable assessment instrument for string instrument performance. The Zdzinski/Barnes String Performance Rating Scale (SPRS) rated five factors: interpretation/musical effect, articulation/tone, intonation, rhythm/tempo, and vibrato. The overall interjudge reliability was between .87 and .93. Contrary to The Farnum String Scale, Zdzinski and Barnes’s rating scale includes intonation as a factor in assessing string performance because intonation is a particular technical challenge for string instruments.

The SPRS was designed to assess prepared performance including all performance components (pitch, rhythm, articulation, interpretation, and the skill vibrato) which are particular to string instruments. I did not test these skills with the chosen vocal
sight-reading instrument, which tested only pitch skills and intonation in order to assess students' auditory representations for pitch. A scale that measures auditory representations for pitch during instrumental sight reading was not available for use in this study, nor was a reliable sight reading assessment tool for string instruments. Usually sight-reading tests for wind or string instruments would measure instrumental performance, i.e. technical skills on the respective instrument, in addition to notational and aural skills and conceptual understanding; however, I examined not just the development of auditory representations through vocal and instrumental sight reading, but also the relationship between auditory representations for pitch and instrumental skills. In the latter case, the 5 categories of the string performance scale could be used to rate the development of students' instrumental skills, look for growth in them, and compare them with the growth in their aural skills through vocal sight reading. The former purpose could be achieved through using only the Intonation category of the SPRS to infer about development of auditory representations. I deemed the use of this scale appropriate for the present study because: (1) it rates technical skills, (2) it allows for separate rating of intonation, and (3) the reliability and validity were established and adequate.

Instrumental students are habitually accustomed to sight reading music with both melodic and rhythmic components present. Contrary to vocal sight reading, which is an un-acustomed activity for instrumental students, the presence of rhythm in ISR would not have a potentially disruptive effect to the same extent as it would in VSR. In addition, a sight-reading test item without rhythm would not have reflected any growth in
proficiency on the instrument, especially for older students.

Zdzinski and Barnes recommended that a 5-point Likert scale be paired with each rating item. When using this scale judges would choose from Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD) that would be rated 5 through 1. For the present study the developers of the scale recommended using only 4-point Likert scale and omitting Neutral (N) rating (Appendix C).

Zdzinski and Barnes did not recommend specific playing materials to be used with the rating scale. DeStefanis (2004) used a researcher-modified form of the SPRS to rate the performances of four test pieces from the *Do It! Play Strings* method book. The interjudge reliability in DeStefanis's study was .82, but the vibrato factor was omitted to make the rating scale more suitable for beginning string players.

For the present study, sight-reading examples previously used at the Junior Orchestra Clinic auditions (sponsored by the State Band and Orchestra Association) were used. These examples were written specifically for each of the four string instruments (violin, viola, cello, and bass), so that they reflect the particular technical characteristics and challenges of each type of string instrument, and were intended for orchestra students in 7th through 9th grade. Although these examples were below the proficiency level established for 10th through 12th grade orchestra students, different sight-reading examples for 11th grade students were not used. The objective of the present study was not to determine students' level of technical proficiency, but to look for growth in their

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instrumental skills and sight reading throughout their school orchestra experience; therefore, all three grade levels in the present study (7th, 9th, and 11th) used the same sight-reading test melodies. Because of the possibility that some students may have practiced these examples for the current auditions, new instrumental sight-reading examples were constructed by the researcher and tested in the pilot study. In order to maintain the same difficulty level, excerpts from the existing ISR melodies were combined to comprise a new melody that was then transposed to D Major which is familiar and common to all four string instruments (Appendix D).

Demographic Information

The Information Sheet used in the present study was designed to collect information pertaining to students' school, grade level, choice of string instrument, years of experience on the chosen instrument, additional instrumental experience (specifically piano), and type of instrumental training (group or private). This information was used for descriptive purposes, but also to gather the data needed to answer the ancillary research questions regarding piano study. The Information Sheet was researcher-made and was the same for all three grade levels (Appendix E).

Design

Participants

The participants for this study were enrolled in orchestra classes in grades 7, 9, and 11 and were not taught by me. The cross-sectional design of the study necessitated the sampling to be at two-year instructional intervals in order to more accurately detect and assess differences in students’ skills. Orchestra students in 6th grade were not tested
because I believed that, as beginning students, their lack of sufficient technical skills would negatively impact their ability to demonstrate their proficiency in sight reading. McPherson (1994), who investigated the relationship between instrumental sight reading and ability to perform rehearsed music, noted that in the beginning stages of training the two skills are not significantly correlated, but the relationship strengthens as the instrumentalists mature.

Students comprising the sample were those who assented to participate in the study and obtained parental consent. They were sampled from approximately 500 string students in 7th, 9th, and 11th grades enrolled in orchestra classes in four participating school districts in the southeastern part of the United States. The objective was to test approximately 50 participants in each of the three grade levels.

**Recruitment**

Initially, five school district that offer string instruction were targeted for participation, but only three agreed to participate; however, it was possible to add a fourth district later. After obtaining permission from the three school districts, I contacted the principals and orchestra teachers at all of the schools with orchestra programs. I presented them with a summary of the study and invited them to participate. After permission was obtained from the school principals and orchestra teachers, I made a presentation in each 7th, 9th, and 11th grade orchestra class to introduce the students to the nature and goals of the study and ask for their participation. Students were each given a recruiting letter (Appendix F), student assent form (Appendix G), and parental informed consent form (Appendix H). The consent form advised parents that their child was
invited to participate in a study concerning development of music skills. The form also provided information about the goal of the study, the role of participants, and the use of results. Parents were informed that the study had been approved by the school administration. They also were assured that participation was voluntary and would be kept anonymous, and that the study would have no effect on the students’ grades in orchestra classes. Students were asked to return the forms to their orchestra teacher within a week. Each orchestra teacher had a list with names of his/her students who had returned the assent and consent forms and were enrolled in the study.

**Pilot Study**

A pilot study was conducted approximately a month before the main study in order to determine interjudge reliability. Participants for the pilot study were string students from middle and high schools that would not be involved in the main study. The enrollment in orchestra in these schools was small; approximately 40 string students in 7th, 9th, and 11th grades were invited to participate. Only those students who signed an assent form and returned a signed parent consent form were included in the pilot sample. As a result, the pilot sample consisted of eleven participants (N = 11).

Three particular problems became apparent during recruitment and pilot testing:

1. Some students were self-conscious about their ability to sing and the quality of their voices. All students were asked to try their best and were assured that the quality of their voice would not be taken under consideration.

2. Some students did not communicate to their parents the permission forms they were given, thus failing to obtain a parental permission. All students were
given about a week to obtain parental permission.

3. Some students who obtained parental permission failed to return it to the researcher, even though they were reminded several times to return their forms. As a result of these problems, only about 25 percent of those invited to participate in the pilot study actually participated.

**Testing procedures.**

The students selected for participation in the pilot study completed their portion of the study during their orchestra class period. Orchestra teachers had a list with the names of students who had returned their signed assent and consent forms. Teachers were instructed to call the students in random order and send them with their instrument to a separate room where they were given a participant number.

The researcher had in the room a portable keyboard, an instruction sheet (Appendix I), two folders, and an RCA digital audio recorder. One folder contained the VSR test melodies (Appendix B) in treble, alto, and bass clefs. Participants were instructed to use the respective clef for their instrument on which they had learned to read music notation. The other folder contained the ISR melody for each of the instruments (violin, viola, cello, and bass) in the clef appropriate for that instrument (Appendix D).

Following Henry’s instructions for administering the test, I remained in the room, gave the instructions, and played on the keyboard the chord progression I-IV-V-I in D major and the first note of the VSR example. The student had 30 seconds to review the example. I played the tonic triad and the first note again, started the recording, and stated the participant’s number. The student then proceeded to sing the first melody of the VSR
test using any syllable he/she chose. Instructions given by Henry also stated that any pitch on which the student starts singing would be considered tonic and points should not be taken if the student did not start on D. The process was repeated for the subsequent sight-singing melodies.

Following the vocal sight reading the student reviewed silently for 30 seconds the instrumental sight-reading example from the second folder. Each student was instructed to play the example to the best of his/her ability. The order of vocal and instrumental sight-reading examples was randomly alternated to avoid test order effect. After each participant completed the test, he/she returned to the rehearsal room to fill out the information sheet eliciting demographic information (Appendix E).

Students’ performances were audio recorded, and the audio recordings were identified using only participant numbers. Students’ names were not included in any subsequent data analysis - only participant number, their scores, and responses to relevant demographic questions were included. Upon the completion of each student's test, the audio files were transferred to a computer with a filename indicating the designated participant number and erased from the audio recorder in order to be ready for the next participant.

**Evaluation procedures.**

The researcher and two experienced orchestra teachers, who did not teach the students participating in the pilot study, served as judges. In a training session judges were acquainted with the scoring guidelines for the sight-singing test (Henry, 1999) (Appendix J) and the sight-reading scale (Zdzinski & Barnes, 2002) (Appendix C). Each
judge was instructed to assign a vocal sight-reading score and an instrumental sight-
reading rating for each participant consistent with the published scoring guidelines. After
reviewing the sight-singing recordings with the investigator, the judges recommended an
addition to the sight-singing scoring guidelines. Considering that many students were
inexperienced singers with untrained voices, instances where the student changed the
octave due to limitations in their vocal range would be regarded as correct (Appendix K).

The SPRS consisted of 28 items, which were grouped under five categories:
Interpretation/Musical Effect, Articulation/Tone, Intonation, Rhythm/Tempo, and
Vibrato. Judges expressed their professional opinions that some of the 28 items of the
rating scale were redundant and that it would be cumbersome and counterproductive to
evaluate each recorded test entry on all 28 items of the rating scale. Examples of such
redundancy were the two items under the Intonation category: "Pitch was mostly
consistent" and "Consistently good intonation on all strings". The judges also noted that
other items, such as "Maintains proper contact point" under the Articulation/Tone
category, would require visual observation in order to be properly rated. As a result, the
judges suggested using only the headings of the five categories (Interpretation/Musical
Effect, Articulation/Tone, Intonation, Rhythm/Tempo, and Vibrato) (Appendix L).
Consequently, the pilot recordings for sight reading were evaluated using an
appropriately simplified sight-reading scoring form.

The pilot study was conducted mainly to (1) train the judges in the application of
the scoring guidelines and the rating scale and (2) to determine interjudge reliability.
Interjudge reliability for vocal sight-reading scores and instrumental sight-reading ratings
on the five-category evaluation was determined using Cronbach’s alpha test for internal consistency. The test yielded a very high internal consistency coefficient of $\alpha = .99$ for VSR and $\alpha = .99$ for ISR. Training the judges during the pilot study proved useful and resulted in high interjudge reliability. Because the judges for the pilot study would also serve as judges for the main study, I felt confident proceeding to the main study with the selected evaluation instruments.

**Reflections on the Pilot Study**

Some changes to the testing and scoring procedures were made as a result of the pilot study. Regarding the procedure for initial tuning (i.e. allowing the participant to acquire a sense of the key and tonality before performing the VSR test), the developer of the test (Henry, 1999) recommended playing on the piano the chord progression I-IV-V-I in the appropriate key. During the pilot study, I used this procedure by playing the chords in both aggregate and arpeggio form in order to help students get a sense of the tonality. This prompted some students to sing the initial notes of the first vocal sight-reading melody as an arpeggio instead of stepwise. Because the first few of the VSR examples in the VSRI started in a stepwise manner, I decided to add a 5-note scale to the initial procedure for establishing a tonal center. This change was necessitated by the fact that the participants for this study were instrumental students. Although some of them may have had prior singing experience, most of the students were inexperienced singers who needed additional help in obtaining a sense of the tonality.

Henry also recommended playing the first note of the VSR example. During the pilot study, however, some students still experienced difficulties matching the starting
pitch and thereafter maintaining the key and the tonal center; therefore, I decided to ask the students to match the first note with their voices prior to recording. This would give those who were not accustomed to singing a chance to hear his or her voice and to ensure that the starting pitch was correct. Furthermore, students could receive additional assurance that the initial pitch was accurate, providing a better chance to continue singing accurately.

The instructions for administering the VSRI Form A directed that participants who had difficulty in one section did not need to continue with the next section (Henry, 1999); however, there were no instructions pertaining to whether students who had difficulty within a section should be allowed to complete all three melodies in that section. For this study, the decision was made to allow each student to go through the first melody and attempt the second one; however, a student was not required to continue if he/she either lost or failed to establish a tonal center for the first two melodies.

**Main Study**

**Recruitment and Sites**

The main study began immediately after the interjudge reliability was established during the pilot study and deemed sufficient. Originally, five school districts were invited to participate in the study. Twenty-one schools (nine middle and twelve high schools) with orchestra programs in these districts were targeted for participation, but permissions were obtained from only three of the districts. At three high schools and three middle schools permission was not granted. In some cases principals denied permission, while in other cases orchestra teachers declined to participate in the study.
As a result, of all 21 schools with orchestra programs in the area, only 15 participated, of which six were middle schools and nine were high schools.

In order to use the time efficiently, I started the testing at some schools while still recruiting at others, especially since it was unlikely that students from different schools might have shared information about the testing to an extent that would be a threat to the internal validity of the tests. During the recruitment it became apparent that 11th grade students enrolled in orchestra programs were the least numerous of the three grade levels to be studied. A possible reason for that low enrollment in 11th grade could be schedule conflicts with other required high school courses which caused many 11th grade string players to be unable to take orchestra class. In order to maintain relatively equal sizes for the three groups in this study, the recruiting area was expanded to include 9th and 11th grade orchestra students from an additional high school in a fourth district. This brought the total number of schools from which the sample was drawn to ten high schools and six middle schools. Still, the group of 11th grade students for the study remained the smallest of all.

The pilot study took place during the second semester of the school year. The main study started shortly before the end of that school year at schools different from those in the pilot study; however, there was not sufficient time before the end of the school year to recruit and test at all schools from which permission had been obtained. During the fall semester of the next school year the main study continued at all schools from which permission was obtained. Thus, at some schools the testing took place during two consecutive school years with samples from different groups of students. In essence
this constituted another means to increase the number of participants for the study.

Recruitment procedures and the problems associated with assembling the sample (such as reluctance to participate because of concerns regarding the singing portion of the tests or failure to return the signed permission forms) were the same as for the pilot study. Orchestra students in 7th, 9th, and 11th grades at each participating school were provided with a letter of recruitment, assent and consent forms, (Appendices G, H, and I), and asked to return them within a week. In addition, I explained the goals of the study and gave them the opportunity to ask questions. Again, the singing portion of the study was a concern to many students; however, they were assured that the quality of their voice while singing would not be evaluated and that the recordings would remain completely anonymous.

**Main Study Participants**

A total of 498 orchestra students from sixteen schools in the four districts were invited to participate, of which 180 were enrolled in 7th grade, 212 were in 9th grade, and 106 were in 11th grade. Only those students who assented to participate and obtained parental consent were included in the study. Permissions were received from forty-six 7th grade, fifty-nine 9th grade, and thirty-eight 11th grade orchestra students. Thus, the sample for this study was comprised of 143 participants, which was almost 29 percent of the total pool of orchestra students in the four school districts. Seventh-grade students comprised 32.2% of the total sample, ninth-grade students were 41.3%, and eleventh-grade students constituted 26.5% of the total number of participants.

There were 13 different teachers who taught these students, some of them
teaching at both middle and high school levels. All teachers at the middle school level used the same curricular materials, the method book *Essential Elements for Strings 2000* (Allen, Gillespie, & Hayes, 2000), and none incorporated singing in their orchestra classes on a regular basis. At the high-school level the curriculum was composed essentially of scales and music repertoire intended for performance.

The study relied on voluntary participation on the part of the students and signed permission from parents; hence, random assignment to groups was not possible. As with any voluntary participation, it was possible that students who chose to participate were more highly motivated to improve their musicianship skills than were nonparticipants. Also, because the study asked participants to sight sing, it was possible that those with previous singing experience, such as participation in a school, civic, or church choir, were less likely to be intimidated by the singing portion of the study and, hence, more likely to participate willingly. Still, many of the participants in the study shared with the researcher that they had no prior singing experience. Information about the participants’ singing experience was not collected since the focus of the study was whether instrumental training (strings and piano) was related to sight-singing and sight-reading skills, and not whether formal or informal singing experiences were related to these.

Data regarding piano experience were collected from the Information Sheet that every participant filled out after the test. Collection of the data had to rely on students’ own estimate of how many years of piano instruction they had received. Those responses ranged from 0 (no instruction) to 13 years of piano experience. Because students’ estimations may not have been very accurate, the estimates may be assumed to have erred
in some cases by a year; therefore, to allow for possible variances in the accuracy of the years of piano instruction, participants were divided into two arbitrary groups based upon a binary, either/or distinction – no piano experience and some piano experience. Those with piano experience were further divided into a combined beginner/intermediate group (1-5 years of experience) and an advanced group (6 or more years of experience).

The question in the Information Sheet regarding piano experience referred only to the duration (years) of participants' private piano lessons. It was not possible to determine the qualifications of the piano instructor or to assess the quality of piano instruction and curriculum. Furthermore, some participants may have referred to self-study as piano instruction. Because of these confounding variables, years of piano "training" were referred to as years of piano "experience." Students with no experience (n = 88) were placed in a group and accounted for 61.5% of participants in the total sample. Students in the beginning/intermediate group (n=33) comprised 23.1% of the sample and 15.4% were in the advanced group of piano experience (n=22).

**Main Study Procedures**

The changes and adaptations to the testing and evaluating procedures made during the pilot study were implemented during the main study. Students were called by their teacher one at a time to a separate room where they were given a random number. They were identified by this number on the recording of their performance and on the Information Sheet. For the vocal sight-reading test, students were given the chord progression I-IV-V-I in both aggregate and arpeggio form, a five-note scale in ascending and descending order, and were asked to vocally match the first note of the example.
This procedure for establishing the starting pitch and a sense of tonality was repeated for each of the vocal sight-reading melodies that students attempted to sing. Students were given 30 seconds to review each of the VSR melodies before performing it; the same procedure was followed for instrumental sight-reading examples. The order of the VSR and ISR tests was randomly alternated between students to avoid test order effect and respectively the instructions were alternated. Most of the students preferred to play first and sing second, probably because they felt more comfortable using their instruments rather than their voices. Because vocal sight reading was an unfamiliar activity to them, some students had to be prompted to do the vocal sight reading first. The time to test each student varied between 7 and 20 minutes, depending on how many of the VSR melodies the student was performing. After each individual test the student was given the Information Sheet and asked to complete it in the rehearsal room. The entire testing process took a little over one school year.

**Scoring**

The researcher and two independent judges who did not teach any of the participants scored the individual VSR and ISR tests from the recordings. The judges did not know whether they were scoring a 7th grade, 9th grade, or 11th grade student, thus avoiding any possible bias toward older students. Neither were they aware of which school the student was attending in order to avoid any bias toward orchestra teachers. Interjudge reliability was determined during the pilot study and after the main study. Two reliability measures were obtained using Cronbach's alpha test – reliability of judges' VSR scores and reliability of their ISR scores.
Following the instructions given by Henry (1999) in the VSRI, the VSR melodies were judged only for pitch errors. Judges were instructed to mark the incorrect pitches for each test entry, and the researcher calculated the sum of correct pitches. Each note of the VSR melody had a value of 1 point, and the maximum possible number of correct points was equal to the number of notes in the example. Vocal sight-reading scores ranged from 0 to 190 if all three parts of VSRI were performed correctly. If the student was singing correctly, he/she was asked to continue through all nine melodies of the test. If on any of the melodies the student lost the tonal center or failed to establish one, he/she did not continue to the next melody. If the student stopped before the end of a melody, all notes and all remaining melodies after the stop were counted as incorrect.

The ISR test entries were rated following the headings of the five major categories in the Zdzinski/Barnes (2002) individual performance scale. The authors recommend each test entry be given a rating of SA, A, D, SD; therefore the scores for sight reading ranged from 1 to 4, with 4 being the highest rating. Students were rated from 1 through 4 separately for each of the five categories. If the student performed with very minor mistakes on any of the categories and the performance sounded confident and expressive, he/she was given a rating of 4 on that category. A rating of 3 entailed a few noticeable but not major errors in each category. For a rating of 2 the errors were major but appeared to be mostly of errors in execution rather than conceptual understanding. Performances that received a rating of 1 showed lack of technical proficiency and conceptual understanding. A quantitative standard, i.e. number of mistakes, was not imposed upon the evaluators for discriminating between ratings two and three, so that
they could apply their professional teaching experience, thus taking into consideration not only the number of errors but also the nature of the errors. The ratings on the individual categories were aggregated to comprise a composite ISR rating for each student. The composite score ranged from 5 (if all categories received the lowest rating of 1) through 20 (if all categories received the highest rating of 4).

Data regarding piano experience were collected from the Information Sheet that each student filled out at the end of the test. Students had to self-report the number of years of piano instruction they had received. These responses ranged from 0 (no instruction) to 13 years of piano experience.
CHAPTER 4
RESULTS AND DISCUSSION

The purposes of this study were to (1) investigate the differences among 7th, 9th, and 11th grade orchestra students’ VSR and ISR, and (2) examine the relationship between vocal and instrumental sight-reading skills within each grade level and the overall relationship between VSR and ISR of string orchestra players. Additional purposes were to determine whether piano experience is related to differences in VSR and ISR at the respective grade levels and to examine the relationship between vocal and instrumental sight reading based on students’ years of piano experience.

The following primary questions were addressed:

1. Are there significant differences among 7th, 9th, and 11th grade string instrumental students in VSR?

2. Are there significant differences among 7th, 9th, and 11th grade string instrumental students in ISR?

3. Is there a relationship between VSR and ISR overall and at each grade level?

The following ancillary questions were addressed:

1. Are there significant differences in VSR and ISR skills between students who have piano experience and those who do not?

2. Is there a relationship between VSR and ISR of students with piano experience and those without piano experience?
Data Analysis

The wide range of students' abilities in vocal and instrumental sight reading exhibited during the testing resulted in a wide range of means and standard deviations among the three grade level groups. This necessitated testing the assumptions regarding the data, specifically the normality of the distribution and the assumption for homogeneity of variance. The normal distribution assumption was checked using the one-sample Kolmogorov-Smirnov Test, and the null hypothesis of normality was not rejected, indicating that the sample distribution was normal.

Keppel and Wickens (2004) cited several ways to test for differences among group variances and noted that Levene's test was the most accurate and robust. Consequently, the average VSR and ISR scores of 7th, 9th, and 11th grade levels were subjected to Levene's Test of Homogeneity of Variance. In the present study, homogeneous variances could not be assumed in VSR. Keppel and Wickens (2004) stated that "statisticians have developed several tests whose accuracy is less strongly influenced by the presence of heterogeneity of variance than is the standard analysis of variance" (p. 155) and added that one of the more commonly referenced tests for use with samples involving heterogeneous variances was the Welch test.

Mendes and Akkartal (2010) listed three possible solutions to the problem of heterogeneity of variance: (1) appropriately transform the data to achieve homogeneity, (2) use non-parametric tests, or (3) use parametric alternatives such as the Welch test. For the present study, the use of the Welch test was more appropriate than modifying the data which might have changed the results (Mendes & Akkartal, 2010). The other
alternative, non-parametric tests, which also may be used when there is a non-normal
distribution, involve converting the raw data into ranks and may result in loss of
information (Huck, 2008). Because the distribution for this study was normal, the
differences among the groups in VSR were therefore calculated using the Welch Test of
Equality of Means. If the Welch test was significant, a post hoc investigation with the
Tamhane T2 test would be appropriate to use to determine the groups between which
differences existed. Tamhane's post hoc test could be used to make pair-wise
comparisons between group means in cases where equal variance cannot be assumed
(Huck, 2008).

For ISR, the variances were homogeneous, and a one-way analysis of variance
(ANOVA) with the Bonferroni adjustment was performed. When multiple tests with data
from several dependent variables (vocal and instrumental sight reading in this study) are
being conducted, there is a risk of inflated Type I error. The Bonferroni adjustment
procedure adjusts the significance level for the number of multiple tests by "making the
alpha level more rigorous on each of the separate tests" (Huck, 2008, p. 272).

Levine and Hullett (2002) stated that in studies involving testing of null
hypotheses, the significance tests are dependent on sample size. Insufficient samples
could lead to Type I or Type II errors. The p-values in tests for significance reflect both
sample size and the magnitude of the effects studied. As they noted, "there is, however, a
growing recognition of the limitations associated with significance testing and p-values
as the sole criterion for interpreting the meaning of results. . . . As a consequence, many
communication journals have adopted editorial policies that require estimates of effect
sizes and statistical power be reported in addition to significance tests" (p. 612). For this study, the calculated effect size was used to determine the achieved power of the tests.

Vocal sight-reading and instrumental sight-reading scores within each grade level were correlated using the Pearson $r$ correlation coefficient to examine the relationship between accuracy of pitch when sight reading vocally and ratings for interpretation, articulation, intonation, rhythm, and vibrato when sight reading instrumentally. Also, an overall correlation between VSR and ISR using the composite scores for the three groups was calculated. The same tests were performed with the participants divided by years of piano experience. Because of the small number of students involved in piano study, the piano experience variable was not used as a covariate. SPSS, version 20.0 (2011) for Windows™ computer software was used to calculate the statistical tests.

**Validity and Reliability of Tests**

All participants were tested in vocal sight reading using the *Vocal Sight Reading Inventory* (Henry, 1999) (Appendix B). The VSRI was used to test students' ability to sing from notation with accurate intonation. In instrumental sight reading, modified examples from Junior Orchestra Clinics sponsored by the state School Band and Orchestra Association (Appendix D) were used to rate students on the five components from the SPRS (Zdzinski & Barnes, 2002) (Appendix L), which was used to assess students' ability to perform unprepared music. Test materials were the same for all students, and the testing conditions were essentially the same except that the order of testing (VSR and ISR) was randomly alternated. Two recordings were made for each participant – one for his/her VSR performance and one for his/her ISR performance.
The researcher and two judges scored each test; thus, each recording received three independent scores. The average of the three scores was used for the analysis of the data. All of the judges were experienced orchestra teachers who did not personally teach any of the students in the study. Interjudge reliability was determined by using Cronbach's alpha test, which yielded internal consistency values of $\alpha = .95$ for ISR and $\alpha = .99$ for VSR (Table 4.1).

Table 4.1

*Main Study Interjudge Reliability*

<table>
<thead>
<tr>
<th></th>
<th>Cronbach’s Alpha</th>
<th>N of Judges</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISR</td>
<td>.95</td>
<td>3</td>
</tr>
<tr>
<td>VSR</td>
<td>.99</td>
<td>3</td>
</tr>
</tbody>
</table>

**Descriptive Information about the Data**

Each student's ISR test score was rated on five different components (Articulation, Interpretation, Intonation, Rhythm, and Vibrato). Each of the five components received a rating ranging from 1 through 4 using a Likert scale (strongly agree – strongly disagree) that the performance of the component was satisfactory. In addition, a composite score was created by adding the ratings from the individual components for each participant. Thus, ISR scores ranged from 5 to 20, with a score of 5 being the least proficient and a score of 20 the most proficient. The composite ratings from the three judges were averaged and used to calculate the test scores.

Vocal sight-reading test melodies were scored using the note-by-note approach, in which each note sung correctly was awarded 1 point; thus, based upon the cumulative
length of the test melodies, 190 was the maximum possible score. Again, VSR scores
from all three judges were averaged to calculate the tests. Table 4.2 shows the large
differences in the means and variances among the three grade levels in VSR; the means
and variances for ISR, however, were not nearly so large.

Table 4.2
Mean and Standard Deviations for 7th, 9th, and 11th Grade Students in VSR and ISR

<table>
<thead>
<tr>
<th>Grade</th>
<th>VSR Average Score</th>
<th>ISR Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>7</td>
<td>21.35</td>
<td>27.88</td>
</tr>
<tr>
<td>9</td>
<td>36.38</td>
<td>42.36</td>
</tr>
<tr>
<td>11</td>
<td>57.58</td>
<td>58.27</td>
</tr>
<tr>
<td>Combined</td>
<td>37.18</td>
<td>45.35</td>
</tr>
</tbody>
</table>

Students were divided into three groups according to the number of years they
had studied piano. Students without piano experience were given numerical value of 0,
beginning/intermediate group – value of 1, and advanced group – value of 2. Again,
there were large differences in means and standard deviations among the groups in VSR
as evident in Table 4.3, but the differences for ISR were not nearly as large.
### Table 4.3

**Means and Standard Deviations for Groups by Piano Experience in VSR and ISR**

<table>
<thead>
<tr>
<th>Piano Experience</th>
<th>VSR Average Score</th>
<th>ISR Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>N</td>
</tr>
<tr>
<td>None</td>
<td>20.44</td>
<td>88</td>
</tr>
<tr>
<td>beg/inter.</td>
<td>48.21</td>
<td>33</td>
</tr>
<tr>
<td>adv.</td>
<td>87.59</td>
<td>22</td>
</tr>
<tr>
<td>combined</td>
<td>37.18</td>
<td>143</td>
</tr>
</tbody>
</table>

**Research Question 1: Differences Among 7th, 9th, and 11th Grade Students in Vocal Sight Reading**

The first research question examined the differences in vocal sight reading among the three groups of participants – 7th, 9th, and 11th grade students. Because of the differences in the number of students at each grade level and the large differences in the standard deviations of their vocal sight-reading scores, there was a concern about violating the assumptions of the normal distribution. Such large differences warranted further evaluation of the assumption of homogeneity of variances among students in the three grade levels for VSR and ISR scores by using Levene's test for Homogeneity of Variances. The results of Levene's test were significant (\( p < .01 \)) for VSR (Table 4.4). Because the Homogeneity of Variance assumption relative to the VSR data was violated, I deemed ANOVA to be inappropriate for investigating differences among the means.
Table 4.4

Levene’s Test of Homogeneity of Variances

<table>
<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSR</td>
<td>10.77</td>
<td>2</td>
<td>140</td>
<td>.00*</td>
</tr>
<tr>
<td>ISR</td>
<td>3.03</td>
<td>2</td>
<td>140</td>
<td>.05</td>
</tr>
</tbody>
</table>

* Mean difference was significant at the .01 level

Because the variances of VSR scores were heterogeneous, the Welch Test of Equality of Means was performed on the VSR scores (Mendes & Akkartal, 2010). Table 4.5 shows that the Welch test revealed statistically significant ($p < .01$), $F[(2, 79.5) = 7.08, 95\% \text{ CI}]$, differences among the grade level means.

Table 4.5

Welch Test of Equality of Means for VSR

<table>
<thead>
<tr>
<th>Statistic$^a$</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welch</td>
<td>7.08</td>
<td>2</td>
<td>79.50</td>
</tr>
</tbody>
</table>

$^a$Asymptotically F-distributed

Tamhane’s test was used to detect which groups differed significantly from each other. The test revealed that the differences in VSR were statistically significant ($p < .05$) only between 7th and 11th grade levels (Table 4.6).
Table 4.6

*Tamhane Multiple Comparisons Post Hoc Test for VSR Among 7th, 9th, and 11th Grade Levels*

<table>
<thead>
<tr>
<th>Grades</th>
<th>Mean Difference</th>
<th>Standard Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>7</td>
<td>-15.03</td>
<td>6.88</td>
<td>.09</td>
<td>-31.73</td>
</tr>
<tr>
<td>11</td>
<td>-36.22*</td>
<td>10.31</td>
<td>.00</td>
<td>-61.67</td>
</tr>
<tr>
<td>9</td>
<td>15.03</td>
<td>6.88</td>
<td>.09</td>
<td>-1.67</td>
</tr>
<tr>
<td>11</td>
<td>-21.19</td>
<td>10.94</td>
<td>.16</td>
<td>-48.05</td>
</tr>
<tr>
<td>11</td>
<td>36.22*</td>
<td>10.31</td>
<td>.00</td>
<td>10.78</td>
</tr>
<tr>
<td>9</td>
<td>21.19</td>
<td>10.94</td>
<td>.16</td>
<td>-5.66</td>
</tr>
</tbody>
</table>

*The mean difference was significant at the .05 level

Research Question 2: Differences Among 7th, 9th, and 11th Grade Students in Instrumental Sight Reading

Levene's statistic was not significant (p = .05) for ISR scores, thus making it possible to perform the ANOVA procedure to check for differences among 7th, 9th, and 11th grade students in ISR. The ANOVA test revealed statistically significant (p < .01), \( F \) [(2,140) = 34.51], differences among students in the three grade levels in ISR (Table 4.7).
Table 4.7  
*Analysis of Variance for 7th, 9th, and 11th Grade Levels in ISR*

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.84</td>
<td>2</td>
<td>13.42</td>
<td>34.51</td>
<td>.00</td>
</tr>
<tr>
<td><strong>Within groups</strong></td>
<td></td>
<td></td>
<td>.39</td>
<td></td>
</tr>
<tr>
<td>54.45</td>
<td>140</td>
<td>.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81.30</td>
<td>142</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To determine where the differences existed, the Bonferroni *post hoc* test was performed. The pairwise comparisons revealed that the differences were statistically significant (*p* < .05) among all grade levels (Table 4.8)
Table 4.8

*Bonferroni Multiple Comparisons Post Hoc Test for ISR Among 7th, 9th, and 11th Grades*

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Mean Difference</th>
<th>Standard Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>-.54*</td>
<td>.12</td>
<td>.00</td>
<td>-.84 -.24</td>
</tr>
<tr>
<td>11</td>
<td>-1.14*</td>
<td>.14</td>
<td>.00</td>
<td>-1.47 -.80</td>
</tr>
<tr>
<td>7</td>
<td>.54*</td>
<td>.12</td>
<td>.00</td>
<td>.24 .84</td>
</tr>
<tr>
<td>11</td>
<td>-.59*</td>
<td>.13</td>
<td>.00</td>
<td>-.91 -.28</td>
</tr>
<tr>
<td>9</td>
<td>1.14*</td>
<td>.14</td>
<td>.00</td>
<td>.80 1.47</td>
</tr>
<tr>
<td>11</td>
<td>.59*</td>
<td>.13</td>
<td>.00</td>
<td>.28 .91</td>
</tr>
</tbody>
</table>

* The mean difference was significant at the .05 level

**Effect Size and Power**

In addition to testing for significance of the differences among students in the three grade levels, tests to determine the effect sizes of the two variables – vocal sight reading and instrumental sight reading - were also performed. According to Levine and Hullett (2002), eta squared ($\eta^2$) is the most frequently reported estimate of effect size and is "interpreted as a percentage of variance accounted for by a variable" (p. 619). The effect size criteria for comparing two means suggested by Huck (2008) for eta squared are .01 for small effect, .06 for medium effect, and .14 for large effect. According to this scale the effect sizes in this study were medium for VSR (.09) and large for ISR (.33) (Table 4.9).
Table 4.9

<table>
<thead>
<tr>
<th>Measures of Association – Effect Size</th>
<th>$H$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSR × Grade Level</td>
<td>.31</td>
<td>.09</td>
</tr>
<tr>
<td>ISR × Grade Level</td>
<td>.58</td>
<td>.33</td>
</tr>
</tbody>
</table>

Because the ANOVA null hypothesis was rejected, a power analysis was conducted to determine whether the ANOVA had sufficient sensitivity to avoid a Type II error. The greater the power and the sensitivity of the test, the less likely is a Type II error (Keppel & Wickens, 2004). In addition, Huck (2008) recommends that a post hoc power analysis is done "after a comparison of two sample means has yielded a nonsignificant result" (p. 246). In this study the differences between 7th and 9th and between 9th and 11th grade scores in VSR were not significant which necessitated performing a post hoc power analysis. Mendes and Akkartal (2010) and Huck (2008) noted that a power value at or above 80 percent is acceptable as sufficient and adequate. For this study the power in VSR was .93, indicating that the failure to find significant differences among all groups in VSR was not caused by a Type II error.

Discussion

The first and second research questions dealt with differences among the three grade levels in VSR and ISR. The testing tasks and administration procedures were the same for all grade levels; therefore, the differences in the scores are attributable to differences in the skill levels of the participants.
**Vocal Sight Reading**

In VSR, a significant difference was shown only between the two most disparate grade levels tested - 7th and 11th grades. The null hypothesis stated that there are no differences in VSR among the grade levels. It was only partially refuted, given that a significant difference was only found between the two most distant grade levels.

The results from the Tamhane *post hoc* test in VSR did not suggest which factor(s) may have contributed to the lack of significant differences in VSR scores between 7th and 9th and between 9th and 11th grade levels. Similarly, it was not possible to determine what specific factors may have inhibited that development. The absence of specific training in VSR during orchestra classes is one possibility; however, the fact that students did show a significant difference in VSR from 7th to 11th grade may be at least partially based on development of music cognitive skills acquired during their string orchestra experience.

**Instrumental Sight Reading**

The null hypothesis for the second question stated that there are no differences among the grade levels in ISR. The results from ISR scores, however, showed that the null hypothesis was refuted, since there were differences between each of the grade levels.

It was assumed that as a whole the tested skills would improve at the higher grade levels as students accumulate orchestra experience. This was clearly the case with instrumental sight reading. The mean scores steadily increased with grade level, and the *ANOVA post hoc* test revealed significant differences among all of the grade levels. The
researcher's interpretation of these results was that there was growth and improvement in students' ISR skills as they spent more years in school orchestra. This was not surprising, since ISR is a vital part of the orchestra curriculum and is a key component of string orchestra auditions and competitions.

When comparing the results from VSR and ISR it appeared that the improvement in VSR was at a lesser rate than the improvement in ISR where the scores were statistically significant among all grade levels tested. The regular instruction in ISR resulted in a steady increase in students' scores. While the improvement in ISR was expected, the improvement in VSR was surprising. In contrast to ISR, there was a lack of specific instruction in the area of VSR for the students in this study, which may have resulted in the lesser rate of improvement; however, the purpose of the study was not to examine the rate of development of the two skills, but whether an improvement occurred or not. Because VSR is commonly used as an indicator for development of cognitive skills, it can be inferred that there was an improvement in students' music cognition, although the continuous and consistent improvement in ISR suggests that technical skills may be ahead of the cognitive skills for the students in this study. No other studies have been identified that examine the growth of VSR and ISR skills specifically in string players. This study provided empirical evidence that there is improvement in these skills during the years spent in school orchestra.
Research Question 3: Relationship Between Vocal Sight Reading and Instrumental Sight Reading Within Each Grade Level

The third research question pertained to the relationship between VSR and ISR for each of the three grade levels. A Pearson product-moment correlation revealed a significant ($p < .05$), but weak ($r = .36$) correlation between the VSR and ISR scores of 7th graders. The relationship at the 9th grade level strengthened to a moderate ($r = .52$) significant ($p < .01$) correlation. At the 11th grade level the relationship between VSR and ISR grew to a moderately strong ($r = .64$) significant ($p < .01$) correlation. The overall correlation between VSR and ISR for all grade levels was moderate ($r = .59$), but significant ($p < .01$) correlation (Table 4.10).

Table 4.10

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th>$R$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>46</td>
<td>.36*</td>
<td>.01</td>
</tr>
<tr>
<td>9</td>
<td>59</td>
<td>.52**</td>
<td>.00</td>
</tr>
<tr>
<td>11</td>
<td>38</td>
<td>.64**</td>
<td>.00</td>
</tr>
<tr>
<td>Combined</td>
<td>143</td>
<td>.59**</td>
<td>.00</td>
</tr>
</tbody>
</table>

* Correlation was significant at the .05 level

**Correlation was significant at the .01 level

Instrumental sight-reading scores were rated on five different components (Articulation, Interpretation, Intonation, Rhythm, and Vibrato). Each of those components was separately correlated with VSR scores to determine which components
were most closely associated with vocal sight reading. Table 4.11 provides a summary of the resulting correlations. All correlations were moderate, positive, and statistically significant \( (p < .01) \). It is evident that vibrato was most strongly correlated with VSR \( (r = .63) \); rhythm exhibited the weakest relationship \( (r = .47) \).

Table 4.11

<table>
<thead>
<tr>
<th>Component</th>
<th>N</th>
<th>( R )</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulation</td>
<td>143</td>
<td>.54</td>
<td>.00</td>
</tr>
<tr>
<td>Interpretation</td>
<td>143</td>
<td>.57</td>
<td>.00</td>
</tr>
<tr>
<td>Intonation</td>
<td>143</td>
<td>.54</td>
<td>.00</td>
</tr>
<tr>
<td>Rhythm</td>
<td>143</td>
<td>.47</td>
<td>.00</td>
</tr>
<tr>
<td>Vibrato</td>
<td>143</td>
<td>.63</td>
<td>.00</td>
</tr>
</tbody>
</table>

Correlations were statistically significant at the .01 level (2-tailed)

**Discussion**

The third research question examined the relationship between VSR and ISR for each grade level and for all grade levels combined. Additionally, each of the five components of instrumental sight reading (Articulation, Interpretation, Intonation, Rhythm, and Vibrato) was correlated with VSR. All relationships between vocal sight reading and the respective components of instrumental sight reading resulted in positive, significant, but moderate correlations that varied slightly in strength.

The strongest association \( (r = .64) \) was found between VSR and the average of the three judges’ ISR scores at the 11th grade level (Table 4.10), suggesting that as students’
ISR improved their VSR improved as well. At the 7th grade level the relationship between VSR and ISR was statistically significant but weak ($r = .36$), possibly because neither skill is well developed at the 7th grade level. Another explanation could be that the greater variability among individual scores of 7th grade students could have contributed to a weak correlation between vocal and instrumental sight reading group scores. Although the years of playing the instrument outside a school setting were not taken into consideration, some students may have studied their instrument longer than others. In such cases their instrumental sight-reading skills may have surpassed their vocal sight-reading skills, which also may have contributed to a weaker correlation between the two skills.

It is informative to go back to the results from the first two research questions, where significant differences in VSR were found between 7th and 11th grades while significant differences in ISR were found among all grade levels. Both test results suggested that, as instrumentalists mature, they improve in both skills (although it took twice as much time for growth in VSR to become sufficiently significant to be detected by the statistical tests) and the relationship between the skills grows stronger. These findings are in agreement with previous research on the association between VSR and ISR; Elliott (1982) also found the correlation between the two skills to be moderate.

Examination of the relationship between VSR and each of the five components of ISR resulted in moderate (from $r = .47$ to $r = .63$), statistically significant ($p < .01$) correlations. The weakest correlation was found between VSR and rhythm ($r = .47$). It is important to note that the VSR test melodies did not contain a rhythmic component and
therefore rhythm was not evaluated in VSR. Still, the weaker relationship suggests that rhythm was not a substantial aspect of VSR as measured in the present study.

It was anticipated that better intonation skills would exhibit a strong, positive correlation with VSR skills. Both VSR and ISR require the ability to internally process music notation and to form auditory representations. The presence of accurate auditory representations of notated music would normally result in accurate intonation during instrumental sight reading; however, finding nearly the same correlation ($r = .54$) between VSR and articulation as between VSR and intonation suggests that good intonation skills may be related to good articulation skills. Both skills depend on the fine control of left and right hands on the string instrument. In order to attribute incorrect intonation to inaccurate auditory representations, the technical facility on the instrument would need to be developed well above the level of difficulty of the ISR example. It is possible that to some extent insufficient technical skills prevented students in this study from performing with better intonation and articulation.

The strongest correlations were found between VSR and interpretation ($r = .57$) and between VSR and vibrato ($r = .63$). That the strongest relationship was found between VSR and vibrato was not surprising. Vibrato is one of the more advanced skills in string pedagogy, the development of which starts during the intermediate level of training. Naturally, the ability to perform vibrato would be expected to correlate with better interpretation scores because vibrato contributes to the expressiveness and overall musical effect of the performance; hence, the association between VSR and interpretation was the closest in strength to the association between VSR and vibrato. Because vibrato
is a more advanced skill, older or more advanced students were more likely to demonstrate proficiency in this skill. Likewise, older or more advanced students were more likely to demonstrate greater proficiency in VSR, as was evident from the moderately strong correlation between VSR and ISR at 11th grade level ($r = .64$).

**Ancillary Research Questions**

The first ancillary research question examined the differences in VSR and ISR performance of students who had piano experience and those who did not. The second ancillary question related to the relationships between (a) piano experience and VSR skills, (b) piano experience and ISR, and (c), more specifically, whether increased piano experience results in better VSR and ISR.

**Ancillary Research Question 1: Differences in VSR and ISR Based on Piano Experience**

**Vocal sight-reading results.**

Before examining the differences in VSR based on grade level, Levene’s Test of Homogeneity of Variance was performed and revealed that the assumption of homogeneity of variances was violated. The same test was performed with the participants grouped by piano experience. Levene’s test was significant ($p < .01$), indicating that there were large differences among group variances in VSR (Table 4.12).
Table 4.12

*Levene’s Test of Homogeneity of Variances for VSR and ISR and Level of Piano Experience*

<table>
<thead>
<tr>
<th></th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSR</td>
<td>45.55</td>
<td>2</td>
<td>140</td>
<td>.00*</td>
</tr>
<tr>
<td>ISR</td>
<td>1.80</td>
<td>2</td>
<td>140</td>
<td>.17</td>
</tr>
</tbody>
</table>

* Mean difference was significant at the .01 level

This necessitated the use of the Welch Test of Equality of Means to check for significant differences among the groups representing varied levels of piano experience (Keppel & Wickens, 2004). The Welch test revealed statistically significant, \( p < .01 \), \( F[(2, 36) = 14.7] \), differences in VSR of students with different levels of piano experience (Table 4.13).

Table 4.13

*Welch Test of Equality of Means for VSR and Levels of Piano Experience*

<table>
<thead>
<tr>
<th></th>
<th>Statistic(^a)</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welch</td>
<td>14.70</td>
<td>2</td>
<td>36.02</td>
<td>.00</td>
</tr>
</tbody>
</table>

\(^a\)Asymptotically \( F \)-distributed

Further examination of the results with the Tamhane *post hoc* test revealed that the differences were statistically significant \( p < .05 \) between the group with no piano experience and the beginning/intermediate group and \( p < .01 \) between the group with no piano experience and the advanced group; hence, the differences were between the group with no piano experience and the two groups with piano experience in favor of the groups
with piano experience. The difference between the two groups with piano experience (beginning/intermediate and advanced), however, did not reach the significance level (Table 4.14).

Table 4.14

Tamhane Multiple Comparisons Post Hoc Test for VSR Among the Groups with Different Levels of Piano Experience (No Experience, Beginning/Intermediate, Advanced)

<table>
<thead>
<tr>
<th>Piano Experience Levels</th>
<th>Mean Difference</th>
<th>Standard Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>None</td>
<td>Beg/Int</td>
<td>-27.77*</td>
<td>8.86</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Adv</td>
<td>-67.15*</td>
<td>14.64</td>
<td>.00</td>
</tr>
<tr>
<td>Beg/Int</td>
<td>None</td>
<td>27.77*</td>
<td>8.86</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Adv</td>
<td>-39.38</td>
<td>16.87</td>
<td>.07</td>
</tr>
<tr>
<td>Adv</td>
<td>None</td>
<td>67.15*</td>
<td>14.64</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Beg/Int</td>
<td>39.38</td>
<td>16.87</td>
<td>.07</td>
</tr>
</tbody>
</table>

*The mean difference was significant at the .05 level
**Instrumental sight-reading results.**

Levene’s test was not statistically significant for ISR; therefore, the ANOVA procedure was performed to check for differences among the piano groups in ISR (Table 4.15). The results from ANOVA revealed statistically significant ($p < .01$), $F (2, 14) = 19.74$, 95% CI] differences in ISR. The Bonferroni post hoc test revealed that there were significant differences ($p < .05$) among all groups with different levels of piano experience (Table 4.16).

Table 4.15

*Analysis of Variance in ISR for Groups of Piano Experience*

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.88</td>
<td>2</td>
<td>8.94</td>
<td>19.74</td>
<td>.00</td>
</tr>
<tr>
<td><strong>Within groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63.42</td>
<td>140</td>
<td>.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>81.30</td>
<td>142</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.16

*Bonferroni Multiple Comparisons Post Hoc Test for ISR and Groups of Piano Experience (No Experience, Beginning/Intermediate, Advanced)*

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Mean Difference</th>
<th>Standard Error</th>
<th>Sig.</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beg/Int</td>
<td>-.34*</td>
<td>.14</td>
<td>.04</td>
<td>-.67</td>
<td>-.01</td>
</tr>
<tr>
<td>Adv</td>
<td>-.99*</td>
<td>.16</td>
<td>.00</td>
<td>-1.38</td>
<td>-.61</td>
</tr>
<tr>
<td>Beg/Int</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>.34*</td>
<td>.14</td>
<td>.04</td>
<td>.01</td>
<td>.67</td>
</tr>
<tr>
<td>Adv</td>
<td>-.66*</td>
<td>.19</td>
<td>.00</td>
<td>-1.10</td>
<td>-.21</td>
</tr>
<tr>
<td>Adv</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>.99*</td>
<td>.16</td>
<td>.00</td>
<td>.61</td>
<td>1.38</td>
</tr>
<tr>
<td>Beg/Int</td>
<td>.66*</td>
<td>.19</td>
<td>.00</td>
<td>.21</td>
<td>1.10</td>
</tr>
</tbody>
</table>

*. The mean difference is significant at the .05 level

Ancillary Research Question 2: Relationship Between Vocal Sight Reading and Instrumental Sight Reading Based on Piano Experience

In addition to the differences in VSR and ISR scores among the piano groups, the relationship between each of the dependent variables (VSR and ISR) and years of piano experience was examined. The correlation between VSR and piano experience was moderate ($r = .59$) and statistically significant ($p < .01$), but it was weaker ($r = .46$) between piano experience and ISR, although statistically significant as well ($p < .01$) (Table 4.17).
Table 4.17

Total Correlations Between VSR and Piano Experience and ISR and Piano Experience

<table>
<thead>
<tr>
<th>Correlation</th>
<th>N</th>
<th>R</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSR/Piano</td>
<td>143</td>
<td>.59**</td>
<td>.00</td>
</tr>
<tr>
<td>ISR/Piano</td>
<td>143</td>
<td>.46**</td>
<td>.00</td>
</tr>
</tbody>
</table>

**Correlation is significant at the .01 level (2-tailed)**

Correlations between VSR and ISR were also examined for students at each of the levels of piano experience. For the group with no piano experience the correlation between VSR and ISR was moderate ($r = .43, p < .01$) but weaker than the correlation between VSR and ISR for the two combined groups with piano experience ($r = .59, p < .01$). The correlations between VSR and ISR for the two groups with piano experience (beginning/intermediate and advanced) were moderate and approximately the same, ($r = .56, p < .01$ and $r = .53, p < .05$ respectively,) (Table 4.18).

Table 4.18

Summary of Correlations Between VSR and ISR for Each of the Groups of Piano Experience

<table>
<thead>
<tr>
<th>Correlation</th>
<th>N</th>
<th>r</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No piano experience</td>
<td>88</td>
<td>.43**</td>
<td>.00</td>
</tr>
<tr>
<td>Beginning/intermediate</td>
<td>33</td>
<td>.56**</td>
<td>.00</td>
</tr>
<tr>
<td>Advanced</td>
<td>22</td>
<td>.53*</td>
<td>.01</td>
</tr>
<tr>
<td>Combined piano experience</td>
<td>55</td>
<td>.59**</td>
<td>.00</td>
</tr>
</tbody>
</table>

*Correlation was significant at the .05 level

**Correlations were significant at the .01 level
Discussion

Ancillary research question 1 examined the differences in VSR and ISR among the three groups of piano experience. Ancillary research question 2 examined the relationship between VSR and ISR for each of the groups of piano experience. The total correlations between piano experience and each of the two dependent variables (VSR and ISR) were also determined.

Consistent with the findings of differences in ISR among the three grade levels, results from the ANOVA and the Bonferroni post hoc test revealed that there were differences in ISR between each of the groups with differing levels of piano experience. In VSR the Tamhane post hoc test revealed that the statistically significant differences were between the group with no piano experience and the beginning/intermediate piano experience group and between the group with no piano experience and the advanced piano experience group. In short, the differences in vocal sight reading were between the group with no piano experience and the two groups with piano experience in favor of the groups with piano experience. Clearly, the participants’ years of piano experience, whether beginning, intermediate, or advanced, facilitated statistically significant differences in their VSR scores.

The relationships between VSR and piano experience ($r = .59$) and between ISR and piano experience ($r = .46$) were positive and moderate, but a stronger correlation was found between VSR and piano experience. It appears that piano experience was not as closely related to ISR for a string instrument as it was for VSR. The results from this study were consistent with previous research on the relationship between vocal sight
reading and piano study (Daniels, 1986; Dwiggins, 1984; Henry, 1999). These findings provide additional empirical evidence regarding the role of piano study in building musicianship skills.

**Summary**

In this study the development of vocal and instrumental sight reading was examined in two different ways: (1) among three grade levels – 7th, 9th, and 11th, and (2) among three groups with different levels of piano experience. Significant differences in VSR were found between 7th and 11th grades only, while in ISR significant differences were found between each of the grade levels. While these findings suggest there was a growth in string students’ ISR throughout their study in school orchestra, the improvement of VSR was at a lesser rate than for ISR, at least among string players.

Significant differences in VSR scores based on students' levels of piano experience were found between students with no piano experience and those with piano experience in favor of the groups with piano experience, but significant differences in ISR scores were found between each of the three groups with different levels of piano experience. These results suggest that piano experience plays a more substantial role in the development of VSR skills than for ISR abilities. Because VSR is often used as an indicator for development of aural skills, I suggest that piano experience also plays some role in the development of aural skills.

The relationship between VSR and ISR was examined for each grade and for the total sample. The correlation between the two dependent variables was moderate with a definite trend of strengthening toward the upper grades. From the five components of
ISR, instrumental vibrato skills showed the strongest correlation with VSR ability. The definite trend of increased association between vocal and instrumental sight reading as the students matured and accumulated experience playing in a string orchestra could be attributed to improvement in their technical and cognitive skills. The strength of the relationship between the two behaviors increased as the years of piano experience increased, supporting the view that piano study plays some role in the development of music cognition.
CHAPTER 5
SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

Background of the Study

Instrumental instruction in the United States has a long and successful history that has allowed many individuals to have musical experiences that they otherwise would not have had. Many elementary and middle schools provide opportunities for students to learn to play a string or wind instrument. Numerous high schools allow students to continue playing their instruments. Some even offer them AP credit and prepare them for college, should they select a career path into a musical field. Most schools take pride in their orchestra or band programs, and student participants have memorable experiences from the years spent in instrumental ensembles. Unfortunately, for many students these valuable experiences end as the students leave high school (Reimer, 2000).

At the onset, instruction in school instrumental programs primarily consists of learning to manipulate the instrument and learning to read music notation (Dalby, 1999; Hiatt & Cross, 2006). After the initial few years learning the fundamentals of playing the instrument, the focus at the high school level remains on instrumental sight reading, performance, and in many situations may include competitions. During these years spent in school orchestra or band, little to no effort is typically made to teach the complementary components of aural training such as playing by ear, memorizing, or vocal sight reading that would bring the students to enhanced musical understanding and independence (Liperote, 2006; May & Elliott, 1980; Robinson, 1996).
Instrumental sight reading is routinely used in school instrumental programs to assess technical mastery of the instrument and comprehension of music notation (Lehmann, Sloboda, & Woody, 2007). It is a valuable skill, but by itself it does not provide students with the broad foundation of aural abilities that would allow them to know whether what they just heard themselves play was in fact correct and with accurate intonation. One reason for playing with imprecise intonation could be insufficiently developed technical skills on the instrument. More importantly, intonation also depends on the ability to form auditory representations from notated music, which are developed and assessed through aural skills activities. In fact, aural representations need to guide the application of technical skills; therefore well-developed cognitive skills clearly are necessary for correct and confident performance (Lucas, 1994).

Research has identified vocal sight reading to be one of the most valuable aspects in developing the aural skills (Deutsch, 1971; Rawlins, 2005-2006). By engaging the vocal apparatus, singing provides an opportunity to engrave the correct pitch of a tone in one’s mind through the additional dimension of vocal kinesthetic memory. In this way, VSR develops "inner hearing" (Klonoski & Johnson, 2003; Sundberg, 1987) and auditory representations of notated music while at the same time serving as an indicator for the presence and accuracy of the already developed auditory representations.

A systematic approach to development of the auditory representations is described in Music Learning Theory (Gordon, 2003 Edition). With Music Learning Theory (MLT), Gordon provided the music education community with an explanation of how people learn music and how the understanding of music is developed. Holahan and Saunders
(1997) described audiation both as "a definition of the representational 'inner hearing' process in music and further, as a general description of the cognitive processes that give music its syntactic structure. Audiation describes the mind’s ability to perceive, retain, compare, synthesize, reproduce, and create tonal patterns and rhythm patterns" (p. 86). Gordon organized the development of audiation skill into several learning levels. In the most elementary level of discrimination learning, aural/oral, listening to music constitutes the aural process and performing music involves the oral process. A feedback system, referred to by Gordon as a "learning loop", which is necessary for audiation, becomes possible: "The continuous learning loop, which involves moving from aural to oral, back and forth, is the way students develop audiation skill. . . . Both listening and singing are necessary for audiation potential to be realized" (Gordon, 2003 Edition, pp. 90, 91).

Content and skill learning are addressed equally in the MLT, properly sequenced, and complementing each other to facilitate comprehensive understanding of music. In the sequence of learning activities, each new skill is based on the last skill learned, and all are focused on audiation. "For a student to achieve at a given skill level, the student must be taught a level of tonal content or a level of rhythm content in combination with that skill," Gordon explained (p. 137). This means that as students’ technical skills advance, their audiation skills need to be improving as well. Regarding learning an instrument and learning to audiate, Gordon expressed the conviction that "... audiation cannot be acquired simply by learning to play an instrument or by learning to 'read music'" (p. 30).

Despite the availability of this theory and its development into a method for different instruments, aural skills are not systematically taught in most instrumental
programs. Because intonation performance on all instruments must be guided by the auditory representation of notation or sound, insufficiently or incorrectly developed auditory representations would neither serve instrumental players adequately nor prepare them for lifelong engagement with music (Dwiggins, 1984).

In this study I sought to determine whether orchestra students develop auditory representations as they develop their instrumental sight-reading proficiency, and more specifically, to investigate whether vocal sight-reading ability is acquired as a result of development of notational and technical skills on the instrument. The purposes of the study were to examine the relationship between vocal and instrumental sight reading and to assess the extent to which improvement in both abilities across grade levels perhaps translates into a stronger relationship between the two behaviors. Additionally, demographic information was collected pertaining to students' years of piano study. These data were believed to be useful in understanding how vocal and instrumental sight reading are related to piano experience and to explore the relationship between piano experience and the development of both abilities.

**Primary Research Questions**

Research question 1 examined the differences in vocal sight-reading accuracy among the three grade levels. Vocal sight-reading scores increased among the three tested grade levels, but the differences were statistically significant at $p < .05$ only between the two most disparate grade levels (7th and 11th).

There were a small number of students whose vocal sight reading did not even approximate the notes on the page, suggesting that they did not form any auditory
representations from notated music. There were another small number of students who were able to complete the entire vocal sight reading test correctly, suggesting that they were forming correct auditory representations from the notation. Several observations, however, could be made regarding the performance of the majority of the students on the vocal sight-reading test. Some of the students mis-performed stepwise patterns as arpeggiated patterns, even though during the initial tuning students heard a five-note stepwise scale in addition to the I-IV-V-I chord progression. Some students were unable to recover from this mistake and only approximated the contour of the melody without establishing a key, while others were able to establish a tonal center and complete the melody in a new key. The ability to establish a tonal center seemed to be the factor that allowed some students to perform better on the vocal sight-reading test. Inability to establish a tonal center resulted in an inability to produce intervals and tonal relationships that reflected the notes on the page. In the Fine, et al. (2006) study, experienced singers lost the tonal center and the sense of a resting tone because of either melodically or harmonically altered music parts, but in my study, inexperienced students appeared to have lost the tonal center because of an undeveloped tonal sense which resulted in inaccurate auditory representations and, hence, inaccurate intonation.

One of the reasons for the large number of errors in pitch could have been a lack of vocal experience; i.e. some students may have had a correct mental image of how the notes should sound, but lacked sufficient intonation control of their vocal mechanism to produce the necessary tones. Without additional research it is difficult to distinguish between intonation errors due to lack of experience in vocal intonation control and those
due to incorrect auditory representations; a more likely reason for the errors, however, could be the inability to form a distinct mental image of the musical sounds that should be evoked by the notes. Students' inability to create an accurate auditory representation of what the notes should sound like may have resulted in differences between produced vocal tones and note symbols. Thus, it is possible that in this study the unstable intonation resulted from unstable auditory representations of the written notation. If the auditory representations were accurate, the students most likely would have corrected themselves when they produced an incorrect pitch.

Research question 2 compared the differences in instrumental sight reading among the three grade levels. The differences were statistically significant \( (p < .05) \) among all grade levels, suggesting that ISR was improving as students spent more years in school orchestra. This finding was not surprising given that instrumental sight reading has been a routine and essential part of orchestra rehearsal in these schools.

Expression and articulation markings were not indicated in the instrumental sight reading examples because it was believed they might have distracted the students from the focus on pitch and intonation components, which were used to determine the presence of auditory representations from notated music. For the same reason, rhythm was completely omitted from vocal sight-reading examples so that students could focus on pitch during VSR. In addition, during sight reading or auditions, students are not usually instructed to use vibrato; however, if they are familiar with the skill, they would apply it. In this study the interpretation and vibrato were left to the discretion of the students. They were instructed to perform their best, and my observation was that they attempted
the best performance for their level. Some performances (usually by younger students) only approximated the notes on the page, while others resulted in confident and expressive interpretation of the music.

Research question 3 focused on the relationship between vocal and instrumental sight reading for all grades combined and separately within each of the grade levels. The correlations between VSR and ISR within the grade levels were as follows: 7th grade $r = .36, p < .05$, 9th grade $r = .52, p < .01$, 11th grade $r = .64, p < .01$, and combined $r = .59, p < .01$. The relationships between VSR and the respective ISR components were moderate, with the lowest correlation between VSR and rhythm ($r = .47, p < .01$) and the strongest correlation between VSR and vibrato ($r = .63, p < .01$).

The key interest for this study was the relationship between students' VSR and their scores in the Intonation category of the ISR scale; this relationship allows one to make inferences about the accuracy of students' auditory representations for pitch. The correlation between VSR and Intonation was moderate ($r = .54, p < .01$) but significant, indicating that there was a relationship between the intonation on the vocal and instrumental performances. That the relationship was only moderate may be attributable firstly to students' limited technical skills, and secondly to the lack of focus on development of accurate auditory representations in the limited amount of VSR experience these young instrumentalists have received in class. Instrumental skills did not appear to have contributed to accurate intonation in VSR for the younger students, where the correlation between VSR and ISR was weak to moderate ($r = .36$ at 7th grade and $r = .52$ at 9th grade) suggesting that the auditory representations were not strongly
developed during early instrumental training.

Vocal sight reading correlated moderately strongly with instrumental sight reading at the 11th grade level and only with the more advanced skill, vibrato, which was more likely to be exhibited by the older students. It appears that aural skills and instrumental skills were relatively more developed in older and more experienced students. The improvement in instrumental skills as students advanced toward the 11th grade was evident from the significant differences observed in ISR among all grade levels. For the older and more experienced players with more advanced instrumental skills, the use of vibrato naturally resulted in greater expressiveness in their performance as a result of better technical skills. These students also showed better developed aural skills as evidenced by the significant differences in VSR between 7th and 11th grade levels. The correlations between VSR and ISR at 11th grade and between VSR and vibrato were relatively strong ($r = .64$ and $r = .63$ respectively). It appears from the former that students with developed auditory representations from notation were better able to perform the written music correctly. From the latter it appears that students with better instrumental skills were more able to focus on their expressiveness during performance rather than concentrating on technical manipulation of the instrument; in addition, those who have better developed instrumental skills, as evidenced by their use of vibrato, would be better equipped technically to play what they "hear" from the notation. It is reasonable to conclude that older and more experienced players in this study had better developed aural and instrumental skills in contrast to the younger and less experienced students.
The results provided additional information regarding how vocal and instrumental sight reading are related and how this relationship changes with students’ accumulation of instrumental experience, resulting in a definite tendency toward an increased relationship between the two processes with advancement in grade levels. The overall relationship, however, was only moderately strong ($r = .59, p < .01$). A strong correlation would suggest that the two variables are somewhat similar in level of development. If vocal sight reading is an indicator of the development of aural skills and specifically the auditory representations, and the aural skills were improving at the same rate as the technical skills, then the correlation between VSR and ISR at least at the 11th grade would have been strong. Because the correlation was only moderately strong ($r = .64, p < .01$), the aural skills, as represented by the VSR scores, were not as developed as the technical skills, as represented by the ISR scores.

**Ancillary Research Questions**

Because factors (other than experience in playing a string instrument) that may have contributed to improvement in vocal sight reading were not evident from the primary findings, an additional potential factor, students' piano experience, was also examined. A secondary analysis was conducted to determine the relationship of piano experience to the development of VSR and ISR. Three groups of students with differing levels of piano experience were formed (No piano experience, $n = 88$, Beginning/Intermediate, $n = 33$, and Advanced, $n = 22$). Students with piano experience (Beginning/Intermediate and Advanced, $n = 55$) comprised approximately one third of the total sample.
Ancillary question 1 compared differences in the VSR and ISR processes among the three levels of piano experience. The differences in instrumental sight reading were statistically significant between each of the groups \((p < .05)\), but a statistically significant difference \((p < .05)\) in VSR was found only between the group with no piano experience and the two combined groups with piano experience favoring the groups with piano experience.

Ancillary question 2 examined the relationship between vocal and instrumental sight-reading scores when students were stratified by their piano experience. These additional correlational analyses indicated a stronger relationship \((r = .59, p < .01)\) between the two sets of scores for students with some piano experience (beginning/intermediate and advanced groups) than between VSR and ISR for students with no piano experience \((r = .43, p < .01)\). It was evident from the results that level of piano experience does play a role in vocal sight reading. The stronger relationship between the VSR and ISR scores for the students with piano experience indicates that both sets of scores are more closely related than for the students without piano experience and that students with piano experience were better at vocal sight reading than the students without piano experience.

**Role of piano experience.**

The findings from the two ancillary questions suggest that some piano experience makes a difference in students' VSR scores. Presuming that students have played piano from notation, it could be argued that the placement of the piano keys in a linear (horizontal) array on the keyboard possibly helps to aurally and visually establish a
correspondence with the linear (vertical) arrangement of notes on the musical staff. An additional benefit of piano study for string players could be the opportunity that piano experience allows to hear a definite pitch from the notation as opposed to the sometimes unstable intonation in beginning strings classes.

If the pitch that instrumental students hear serves as a reference for auditory representations to be built upon, then pitch references that are unstable (as may be the case during beginning strings training) may be expected to result in unstable auditory representations. It was evident from the study that many aural skills did develop through playing string instruments; however, because the developing left hand technique that is responsible for intonation on the string instruments may be imprecise, the developing auditory representations may be imprecise as well. This is not the case with playing piano, where even in the beginning stages of study the pitch is fixed and probably results in formation of more accurate auditory representations. The piano's definite pitch could be helpful in establishing anchor points in a student's mind for the correct pitch of the notes. The role of the piano for students of non-fixed pitch instruments and voice would be to provide a definite sense of pitch while singing or playing from notation and most likely an implicit understanding of the tonal framework.

A third possibility is based upon the observation that piano experience, from nearly the beginning of instruction, is experienced by the student as involving harmony. It is possible that for students in this study who had studied piano the harmonic aspects of basic piano instruction developed a rudimentary sense of tonal center that may be transferable to VSR and possibly to their string playing. In addition to encouraging more
accurate auditory representations, piano experience may also promote the development of other cognitive skills such as tonal sense and pattern recognition.

Implicit aural skills.

Even though VSR was not explicitly being taught to the students in this study, improvement in their VSR across the three grade levels studied was nevertheless apparent. The basis for this improvement, however, was not clear. Data from this study do not support any conclusions with respect to how students with no piano or vocal training, who had practiced ISR only on their respective string instruments, still developed their auditory representations to some extent and were able to show improved performance in VSR as was evident from the significant differences in VSR scores between 7th and 11th grade levels.

Although VSR was not being explicitly taught in string classes, it is apparent that some aural skills development was taking place that may have contributed to the acquisition of basic ability to form auditory representations from notation. Students in string classes are encouraged to discriminate between the tones they hear and to match the tones they produce to the tones that teachers often demonstrate. Students are regularly given feedback on their intonation and have an opportunity to listen to different harmony parts during string rehearsal. The correlational analyses in this study resulted in a positive correlation between VSR and ISR, indicating that vocal and instrumental sight reading are related behaviors, probably because of the underlying cognitive processes that they share. The older students performed better than the younger, and the association between the two behaviors strengthened with advance in students' grade level. The
growth in students' aural skills, indicated by their VSR scores, however, was at a lesser rate than the growth in their ISR as shown by the results from the sample in this study.

**Theoretical Models**

By considering the findings from this study and what previous research has established about ways of developing sight-reading, I propose two theoretical models. The first one delineates the development of vocal sight reading and instrumental sight reading according to the trends in the related literature. The second model attempts to explain how they are related.

**Development of Sight Reading**

Sight reading has been established by previous research (Waters, Townsend, & Underwood, 1998) as a pattern-recognition and priming task involving auditory representations derived from music notation. It also has been established through research that pattern recognition can be taught through training with tonal patterns (Gordon, 2003 Edition; MacKnight, 1975; Wolf, 1976). The premise that a large part of the music literature is grounded on major/minor tonalities is at the foundation of Gordon’s (2003 Edition) *Music Learning Theory*, in which the tonal sense is developed by playing and singing tonal patterns. Gordon stated that the orderly arrangement of sounds into patterns constitutes the syntax of music. Learning these patterns in sequential order during the aural/oral process provides the basis for mastering the internal syntactical meaning of the music. In particular, singing tonal patterns facilitates the development of auditory representations and VSR accuracy through vocal kinesthetic memory (Sundberg, 1987) while simultaneously relying upon auditory representations for
feedback and accuracy. The same process applies during ISR in which playing tonal patterns develops kinesthetic memory and also influences the formation of auditory representations (Wolf, 1976). Hearing the music in one's mind, therefore, helps one to sight read correctly and confidently. The process of developing a tonal sense and increasingly accurate auditory representations and forming predictions about the flow of the music should facilitate increasingly accurate performances of new music during vocal and instrumental sight reading.

Figure 5.1 suggests an interconnectedness among the components of cognitive skills that contribute to the development of VSR and ISR and, ultimately, to the objective of playing and singing music independently. This model of the development of vocal and instrumental sight-reading abilities suggests that they are related through the common processes of music cognition: the ability to hear music in one's mind, developing a sense of tonal center and pattern recognition through playing and, particularly, singing of tonal patterns, and improving one's ability to anticipate the flow of the music.
It appears that the steps in developing audiation in Gordon's MLT are essentially similar to those outlined in this model for developing vocal and instrumental sight reading. Gordon's recommendation of using tonal-pattern training through singing and playing to develop auditory representations, tonal sense, and predictions about the flow of the music, and in turn to influence sight-singing and sight-reading competence, seems to be a comprehensive approach that should be carefully considered for use in instrumental classrooms.
Relationship between VSR and ISR

In MLT, one of the last-introduced activities is learning the notational symbols for tones that students have already learned to recognize by sound. Gordon (2003 Edition) noted that when students learn to read and write music notation by associating symbols with the syllables and sounds of the patterns they represent, they are engaged in notational audiation. Students are able to hear the musical sound and give syntactical meaning to what they see in music notation before it is performed. When MacKnight (1975) wrote that "in order to read tones effectively, the reader must recall an aural referent from what he sees in notational form" (p. 25), the author probably was referring to notational audiation.

The ability to form auditory representations from notated music before the sound is produced is certainly present for skilled sight readers, as shown in Figure 1.1 (on page 12); however, in contrast to those skilled in vocal and instrumental sight reading, the process is different for unskilled sight readers. Beginning instrumental students usually are not able to imagine the sound in advance. Rather, as Pratt, et al. (1998) noted, "when we are taught to sight-read on an instrument, we are usually encouraged to 'get the notes right' as the first priority" (p. 107). It is, according to them, the learning of the notes through vocal sight reading that would force students to form an image of the notes in one's mind instead of just responding to external stimuli and simply reproducing them on an instrument.

Skilled sight readers form and use auditory representations from notated music prior to producing the sound, and these auditory representations contribute to accurate
vocal intonation and intonation on instruments with non-fixed pitch. In this study, however, only a small number of students would fall under the category of skilled sight readers who played correctly and confidently with good instrumental control and intonation and who obviously were forming auditory representations prior to playing. The majority of the students in this study exhibited lesser degrees of instrumental sight-reading ability; for these less-skilled sight readers, the presence and use of an instrument for tone production in instrumental sight reading may not have encouraged and enabled them to form and use auditory representations of notated music prior to playing the notes. It is also possible that at the early stages of training the challenges of technical manipulation of the instrument take priority and cause students to focus on playing the notes rather than on how they should sound.

Kopiez and Lee (2006) found that the role of auditory representations from notated music was not significant during the lower levels of sight reading complexity because of the relatively easy playing material on the instrument for which technical skills were sufficient. For instrumentalists unskilled in sight reading, technical ability may substitute for auditory representations. In this situation, the auditory representations are likely to be developed after the sound is produced and possibly not quite accurately because of undeveloped technical skills and unstable intonation. Adequate technical proficiency may conceal inaccurate or absent auditory representations, thus making instrumental sight reading an unreliable indicator for assessing underlying cognitive processes. Conversely, the lack of technical proficiency in ISR may be an obstacle with respect to revealing the presence and accuracy of the auditory representations. If the
auditory representations are not developed, good technical skill that relies on kinesthetic memory may result in good ISR, but may not result in good VSR, hence the need to evaluate the auditory representations through VSR.

In skilled vocal sight reading the auditory representations must be present before the sound is produced because the performer cannot rely upon an instrument for tone production. Failure to form and use auditory representations before the sound is produced would result in incorrect vocal intonation. Conversely, a lack of vocal control may interfere with both the formation of accurate auditory representations and with the manifestation of auditory representations through performance, i.e., accurate vocalization; however, if vocal control is developed, VSR would more precisely reflect the accuracy of auditory representations because the student's vocal instrument correctly and directly reflects what he/she hears internally. Thus, instrumental sight reading cannot be, and probably should not be, a substitute for vocal sight reading when evaluating the development of students' auditory representations. Finally, as is intuitively obvious, because instrumental sight reading also measures instrumental skills in addition to aural skills and conceptual understanding (Randel, 2003), vocal sight reading cannot be a substitute for instrumental sight reading when measuring instrumental skills.

Figure 5.2 represents possible factors and outcomes in the evaluation of auditory representations with unskilled students, i.e. when either accurate auditory representations or good technical skills are absent. It is apparent that unskilled students produce out-of-tune performances except where good instrumental skills facilitate correct intonation, which does not provide reliable information about the state of the auditory
representations. The accuracy of the auditory representations can be evident and reliable only for students with vocal intonation control. When both accurate auditory representations and technical skills are absent (not shown in the figure), no meaningful assessments are possible. (Figure 1.1, on page 12, represents the meaningfulness of the observations when both auditory representations and technical skills are present).

**Figure 5.2.** Relationship among VSR, ISR, and auditory representations in unskilled musicians

Music learning is a complex process, as evident in Gordon's MLT. It starts with a continuous "learning loop" of listening and performing. Performing can be accomplished both by singing and playing on an instrument, and in both cases it requires development
of the physical facility to control the performing medium. Notational symbols for the
sounds are presented after some cognitive processes are in place (i.e. auditory
representations, memory for tonal patterns, tonal sense), and then the notational symbols
will evoke corresponding auditory representations for the sounds they represent. In this
case the presence of auditory representations would be accurately detected through vocal
sight reading; however, if training on an instrument has not involved singing at the early
stages, neither VSR nor ISR may be accurate indicators of the presence of auditory
representations (Gordon, 2003 Edition). It appears that in order for vocal sight reading to
be an accurate indicator of auditory representations, singing in general and from notation
would need to be practiced during the early stages of development of the cognitive skills.

**Implications for Teaching Instrumental Music**

Gordon’s MLT has shown that singing in beginning instrumental classes does not
hamper the development of performance skills, but instead is a prerequisite and a means
for meaningful and holistic instrumental training oriented toward teaching for lifelong
engagement with music. Many authors and music educators support the idea that
singing, learning notation, and playing an instrument should go hand in hand during
beginning instrumental lessons. Such an approach is not only possible, but also highly
desirable for attaining the long-term benefits of instrumental music instruction (Hiatt &
Cross, 2006). Gordon's MLT provides an example of how to develop vocal and
instrumental intonation control through singing and playing by ear and from notation.
Similarly to Sundberg’s (1987) advice to singers to "hear" the target pitch in their
imagination before producing it, which is accomplished through memorizing intervals
and building a sense of tonality, Gordon (2003 Edition) noted that it is important for musicians to first hear the sound that they are about to make. He was apparently referring to the development of auditory representations, i.e. the music that will sound in their minds when they learn to audiate. For Gordon the development of auditory representations and the cognitive understanding of music was a priority goal and he went on to state that "there are two instruments students must learn in order to make satisfactory progress in instrumental music: their audiation instrument and the actual instrument" (p. 273). The audiation instrument will help them know what sound to produce and whether it is correct or not, while the second will help them know how to produce it. Gordon also added that teachers of instrumental music should always keep the differences among imitation, memorization, and audiation in mind. When students are hearing what they just played and are simultaneously hearing what will come next as they are playing, they are audiating, because they are making instant generalizations about music syntax and style. On the other hand, when students hear only what they are playing as they are playing it, they are imitating through memorization or by reading from note to note. . . . Students cannot learn to audiate by just playing an instrument, quite the contrary: students must first be able to audiate if they are ever to be able to express their audiation through an instrument. (pp. 274, 275)

Informal discussions with instrumental music teachers suggest that they recognize the importance of aural skills training for their students. As McPherson pointed out, "...activities which encourage students to 'think in sound' are crucial for musical success and an important ingredient of good teaching practice" (p. 332). Nevertheless, the majority of teachers for students participating in the study commented that they rarely ask the students to sing in orchestra classes.

The problem of connecting the voice to inner hearing could be a substantial one,
leading some students to believe that they cannot sing and subsequently to avoid any singing activities despite the potential benefits from singing. Vocal sight reading involves most all components of aural skills: pitch matching and discrimination, as well as pitch recognition and recall, are particular aural skills that can be taught through VSR. Additionally, singing could be used for improvising and creating new music. Vocal sight reading, coupled with playing by ear, could mitigate the excessive focus on notation, upon which instrumental students are so dependent, and help develop cognitive understanding of music. Gordon’s advice on instrumental music instruction stressed the importance of first singing tonal and rhythm patterns and then performing them on the instrument:

It is of the utmost importance that learning sequence activities be used in instrumental activities to remind students to audiate as they play their instruments, to teach students how to perform musically, and to teach students how to detect and to correct errors, because this is the value, the essence of learning sequence activities in practical application. (2003 Edition, p. 276)

Singing could make learning instrumental music a truly aural experience. Some singing activities, especially at the beginning level, if performed regularly, would not detract from, but rather would enhance the development of technical skills and ultimately would translate into better sight-reading and performance skills (Kendall, 1988). In McPherson's (1993) model the role of one of the components of aural skills, playing by ear, was examined as a contributing factor in development of aural skills. Playing by ear is certainly a means for developing aural skills, but it also requires some technical proficiency on the instrument; at the early stages of instrumental training the voice is a more readily available tool for developing a cognitive understanding of music that can
lay the foundation for successful instrumental training. Singing from notation in instrumental class could afford students the opportunity to internalize the notes as they are being learned as symbols and produced on the instrument. Opportunities identified by research for incorporating vocal sight reading in the beginning and intermediate levels of instrumental training include (1) singing the songs that are being played or (2) singing scales and tonal patterns (Dunlap, 1989; MacKnight, 1975). Findings from the present study also provide a persuasive rationale for including vocal sight reading in the regular school orchestra rehearsal in addition to instrumental sight reading.

Although teachers frequently are aware of the benefits that accrue from aural skills instruction, parents, school administrators, and sometimes students themselves do not understand the importance and long-term benefits of aural skills instruction for developing musicianship. The research community may need to help educators in an effort to enlighten the perceptions of administrators and students. A survey of the attitudes of parents, students, and administrators toward aural skills instruction could be informative regarding the next steps in this direction.

**Recommendations for Future Research**

A study similar to the present work could be expanded to include band students as well as orchestra students. The present study was carried out in orchestra programs because preliminary review of the literature indicated that, compared to the overwhelming pool of research that includes band or choral students, studies with orchestra students are relatively few. Such an expanded study could compare auditory tonal skills of string, wind, and keyboard instrumentalists and could examine whether
choice of instrument makes a difference in the acquisition of vocal and instrumental sight-reading skills. In this regard, it would be most helpful for string educators and researchers to have a reliable sight-reading assessment tool designed for strings that could assess both cognitive aural skills and instrumental technical skills. Such a tool should be compatible with the vocal sight-reading tool so that the development of aural representations through vocal and instrumental training could be studied.

In the present study, information regarding students' singing experience was not collected because the focus was on the relationship between instrumental and vocal sight reading of instrumentalists. True to previous research, piano experience proved to be related to better vocal sight-reading (Henry, 1999). Findings from previous research also suggested that instrumental experience resulted in a greater beneficial effect on students' VSR than did singing experience alone (Daniels, 1986; Demorest, 2001). Another similar study could extend previous research by analyzing students' vocal experience along with their instrumental training.

For students in this study the lack of experience in VSR and singing from notation in general was a confounding variable that created difficulties in distinguishing among the possible causes for poor vocal intonation. It appeared, however, that singing (and playing) with inaccurate intonation most likely was a result of failure to form accurate auditory representations from the notation, but it could also result from an inability to connect the auditory representations to the performing medium, voice or instrument. A study could be designed to make a clear distinction between the two reasons and to find methods to help students improve their intonation.
A number of experimental studies have compared two or more groups of students that have been taught using different teaching methods. A study with instrumental students could be devised to compare teaching methods that include aural skills instruction with the traditional approach of learning the instrument and notation simultaneously. New instructional materials, especially for strings, should be developed to reflect the need for inclusion of aural skills in the regular rehearsal. Such materials ideally would be grounded in Gordon's MLT, the established research on tonal patterns and the development of aural representations.

**Concluding Comment**

Instrumental students often spend seven or eight years participating in school orchestra or band programs. This paper began with an introductory scenario reflecting that experience. If during these years the students' experiences had been focused on developing aural skills to the same degree as the focus on technical skills and music literacy, the opening scenario might have unfolded quite differently.
APPENDIX A

Vocal Sight Reading Inventory

Form A

Sight Reading Examples

I.

1.

2.

3.

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APPENDIX B

Sight-Singing Test Melodies

Form A Transposed to D Major

Part 1

Ex 1

Ex 2

Ex 3

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Part 2

Ex 1

Ex 2

Ex 3
Part 3

Ex 1

Ex 2

Ex 3
APPENDIX C

String Performance Rating Scale

Participant #________

<table>
<thead>
<tr>
<th>Interpretation/Musical Effect</th>
<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of style in performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very musical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melodic Phrasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtle nuances lacking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry-too technical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate range of dynamics</td>
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<td></td>
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</table>

<table>
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<tr>
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<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
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<tbody>
<tr>
<td>Using correct proportion of weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear articulation produced by left hand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintains proper contact point</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Arm weight draws full sound from string and speed with bow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tone is full without harshness on forte</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>String crossings are controlled/smooth</td>
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<td>Pitch was mostly consistent</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Half steps not close enough</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consistently good intonation on all strings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Able to adjust pitch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Played out of tune</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor thirds are sharp</td>
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<td></td>
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<th>SA</th>
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<tbody>
<tr>
<td>Uneven rhythm</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent rhythm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tempo is not stable</td>
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</tr>
<tr>
<td>Rhythm was distorted</td>
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</tr>
<tr>
<td>Correct rhythms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Tempo is stable during technical passages

<table>
<thead>
<tr>
<th>Vibrato</th>
<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full, rich vibrato</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibrato is continuous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibrato is even</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibrato is irregular</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

Sight - Reading Test Melodies

Violin

\[\text{Music notation image}\]
Violoncello
Double Bass

\[\text{Music notation image} \]
APPENDIX E

Student Information Sheet

Participant #______________

Please answer the following questions:

1. My principal musical instrument is _________________

2. I have been playing the above instrument for ___________ years.

3. I have played in school orchestra for ___________ years.

4. I have received private lessons on the above instrument for ___________ years.

5. I have received instruction for at least one year (either privately or school group instruction) on other instrument. (please list the instrument).
   _______________________________

6. I have been playing piano for ____________ years.

7. The school I attend is ________________________________

Please indicate your current grade level:

7th grade □

9th grade □

11th grade □

Thank you for your participation!
Dear Orchestra Student,

My name is Penka Spaulding and I am a doctoral student at Boston University. As part of my studies I am doing a research project that involves orchestra students in 7th, 9th, and 11th grade. You will be asked to sight-read a short melody which is no more difficult than the sight-reading at Junior Orchestra Clinics. The procedure will be the same: you will have 30 seconds to review it and play it on your instrument. Next, you will be shown another short melody and asked to sing it. You can use any syllable or letter names if you prefer.

Please do not be intimidated by the singing part. Your singing voice will not be evaluated. At the beginning of your instrumental study you have probably been singing the melodies in your books before you played them. If you have not done this, you can imagine how you would play the melody on your instrument and follow the melody line. The melodies for sight singing are much easier than the ones for sight-reading.

Your participation is completely voluntary. Your orchestra grade will not be affected should you decide not to participate. If you choose to participate, you can still drop out at any time without consequences. During the tests some of you may experience slight performance anxiety which might be similar to the anxiety during your regular playing tests. In such case, please keep in mind that you are helping to collect information, improve instruction and facilitate student learning. Your teacher will not know your score on the test and you will not be graded on it.

Please be assured that your participation will be completely anonymous. There will be no personal information collected; you will be assigned a participant number and your scores will be identified only by your number. It will be impossible to link together your name, your number, and your score. Your teacher will know only your name, while the judges and myself will know only your number and score. At the end the scores will be reported in aggregated form, not individually. Therefore, I strongly encourage you to participate and try your best.

You will receive an Informed Consent form which your parents need to sign if they let you participate. There is a Student Assent form for you to sign, indicating that you agree to participate. Please return the forms to your teacher in the next 2-3 days; ask for another copy if needed.

If you have questions or concerns at any time during the study, please contact me at [email]. Thank you in advance for your willingness to participate.

Sincerely,
APPENDIX G

Student Assent Form

Boston University

RESEARCH ASSENT FORM
Children 12–17 Years of Age

Title of Project: The Development of and Relationship between Sight-Singing and Sight-Reading Skills of 7th, 9th, and 11th grade Orchestra Students

Principal Investigator: Penka Spaulding

Study Background and Purpose
As a doctoral student I am doing a research study which is similar to a scientific experiment. In this research study I will be collecting information to learn more about how sight singing and sight reading are related. I like to find out whether good sight-readers are also good sight-singers. For that purpose I will be looking at students who play a string instrument and are in 7th, 9th, or 11th grade. I would like you to be in the study because you are an orchestra student and play a string instrument.

After I tell you about it, I will ask if you'd like to be in this study or not.

What Happens in this Research Study
If you agree to be in the study I will ask you to sight-read a short melody which is no more difficult than the sight-reading at Junior Orchestra Clinics. The procedure will be the same: you will have 30 seconds to review it and play it on your instrument. Next, you will be shown another short melody and asked to sing it. You can use any syllable or letter names if you prefer. After this performance I will ask you to fill out an information sheet and tell me how long you have been playing and whether you can play other instruments or not.

The research will take place at your school, but in a room other than the orchestra room and your participation will last for about 10 minutes.

Risks and Discomforts
Some things that you may not like may happen because you are in this research. These are some of the things that might or could happen:
1. You may be concerned about how well you will play the melody. There is no need to worry because you will not be graded and your orchestra teacher will not know how well you performed.
2. You may think that you do not have a good singing voice. Remember that you will not be graded for your singing or your voice. Just imagine how you would play the melody and follow it with your voice. Keep in mind that you can always stop if you feel that you cannot continue, but first try your best.

There may be some other things that happen that I don’t know about right now. If I find out about any of these things I will let you know and you can decide if you want to stay in the research or not.

Benefits
You will not receive any direct benefits from participating in the study. Even though you might not benefit, if you participate in this research it could help others by providing the information needed to answer the questions of the study.

Alternatives
Your alternative is to not participate.

Costs/ Payments
The only cost to you for this research is your time. You will not be paid to participate in this research study.

Confidentiality
Please be assured that your participation will be completely anonymous. There will be no personal information collected. When you come to participate you will be assigned a participant number, your performance will be audio taped, and the recordings will be identified only by your number. Nobody will be able to make connection between your scores and your name. The recordings will be destroyed after the study is over.

Voluntary Participation
Do you have to be in this study? No, you don’t. No one will make you if you don’t want to do this. Just tell the researcher if you decide not to do it. Your orchestra grade will not be affected if you decide not to participate. If you decide to join and then later change your mind it is ok. If you decide to join but then don’t want to perform part of the test it is ok.

Contacts
If you have questions regarding this research or if you think you are being hurt by the research now or later you or your parents can contact Penka Spaulding at [redacted] or penkas@bu.edu.
Agreement to Participate

If you sign this assent form it means that you have read it or it has been read to you. It also means that you have been given the chance to ask questions about the study and your questions have been answered. If you sign this it means that you are agreeing to participate and no one is forcing you.

The researchers will give you a copy of the consent form if you wish.

____________________________________
Name of Subject

____________________________________                   __________
Signature of Subject                                                           Date

Penka Spaulding
Printed Name of Person Obtaining Assent

____________________________________      __________
Signature of Person Obtaining Assent                             Date
APPENDIX H
Parent Consent Form

Boston University

RESEARCH CONSENT FORM

Title of Project: The Development of and Relationship between Sight-Singing and Sight-Reading Skills of 7th, 9th, and 11th grade Orchestra Students

Principal Investigator: Penka Spaulding

Study Background
Many music educators are concerned with providing the best learning opportunities for students in school orchestras. Several skills have been identified that contribute to the development of musicianship and this study will look at the relationship between two such skills. The principal investigator, Penka Spaulding, is a doctoral student at Boston University and the project is being conducted for her dissertation research.

Your child will be one of approximately 290 subjects asked to participate in this research. He/she is being asked to participate because he/she is enrolled in orchestra class and this study is targeted toward orchestra students. The entire study will take about three weeks, but your child’s participation will take no more than 15 minutes.

Purpose
The purpose of this study is to learn more about the relationship between the skills of sight reading and sight singing.

What Happens in this Research Study
If your child participates in this study, he/she will be asked to individually play on his/her instrument and sight-sing a short melody. Test melodies will correspond to students’ skill level. The research will take place at your child’s school during one of the orchestra class periods and in a location other than the orchestra room. Orchestra teacher will send the students one at a time to a separate room and each participant will be assigned a random number, which will be used to identify the performances. The test performance will be audio recorded. The order of playing and singing will be randomly alternated. After the performance students will be asked to complete an information sheet, including school, grade, years of training on the main instrument and any other instruments, and additional training such as private lessons.
Risks and Discomforts
There are no known risks associated with participation in the study. It is possible that some students may experience minor performance anxiety, which will not be greater than the anxiety experienced during regular orchestra playing tests. Your child will always be free to take a break, or stop the test. To minimize the discomfort, students will be assured that their orchestra teachers will not know their scores on the test and that the scores will not affect their orchestra grade.

There may be unforeseen risks to the study. If new risks are identified the study staff will update you in a timely way about any new information that might affect your child’s health, welfare, or decision to stay in the study.

Benefits
Your child may receive no benefits or compensation from participating in this study. His/her participation, however, will contribute to the understanding of the relationship between sight singing and sight reading, which may lead to identifying better techniques for developing musicianship in orchestra classes.

Alternatives
Your child’s alternative is to not participate in this study.

Costs/ Payments
There are no known costs to your child for participating in this research study except for his/her time. Your child will not be paid to participate in this research study.

Confidentiality
In this study only orchestra teachers will identify students who have obtained parent permission to participate. The signed consent forms will be returned to the orchestra teachers and then will be kept separate from the research data. All data will be stored in computer files accessible only to the principal investigator and her dissertation advisor, and the data will be destroyed at the end of the research.

Students will be assigned random participant numbers when they come for the test. Any student, who the researcher knows in person, will be removed from the study. Audio recordings will be scored by independent judges who do not teach the students. At the end of the study, audio recordings will be deleted. There would be no code that can link students’ names to their assigned participant numbers. It will not be possible for anyone involved in the research to link together the scores, participant numbers, and names of the participants.

The scores will be kept confidential and may not be disclosed unless required by law or regulation. Your child’s information may be used in publications or presentations. However, since no identifiable information will be collected, the publication will not include any personal information that will allow for your child to be identified.
Information from this study and study records may be reviewed and photocopied by the institution and by regulators responsible for research oversight such as the Office of Human Research Protections, and the Boston University Institutional Review Board.

**Voluntary Participation**
Taking part in this research is voluntary. Your child has a right to refuse to take part in this study. If your child decides to be in this study he/she can refuse to answer any question if they wish. If your child decides to be in this study and then change their mind, he/she can withdraw from the research. In such case the student needs to inform the orchestra teacher about their decision. Refusal to participate will not involve any penalty or loss of benefits to which students are otherwise entitled.

If there are any new findings during the study that may affect whether or not your child wishes to continue to take part in the research, you will be told about them as soon as possible. The investigator may decide to stop your child’s participation in the study without your consent. This might happen if the researcher knows your child in person and she decides that staying in the study will be bad for your child or if she decides to stop the study.

**Contacts**

If you have questions regarding this research or if you have a research related injury, either now or at any time in the future, please contact Penka Spaulding at [penkas@bu.edu](mailto:penkas@bu.edu) or the faculty advisor, Dr. Jay Dorfman at [jdorfman@bu.edu](mailto:jdorfman@bu.edu) or at [irb@bu.edu](mailto:irb@bu.edu).

You may obtain further information about your child’s rights as a research subject by contacting the Boston University Institutional Review Board for Human Subjects Research at 617-358-6115 or [irb@bu.edu](mailto:irb@bu.edu).
Agreement to Participate

By signing this consent form you are indicating that you have read this consent form or it has been read to you. You are also indicating that you have been given the opportunity to ask questions about the study and all of your questions have been answered to your satisfaction. By signing the consent form you are indicating that you voluntarily agree for your child to participate in the study. You will be given a copy of the consent form to keep if you wish.

____________________________________
Name of Student

____________________________________                   __________
Signature of Parent/Guardian                                            Date

___________________
Penka Spaulding

Printed Name of Person Obtaining Consent

_________________________________                        ___________
Signature of Person Obtaining Consent                            Date
"Thank you for agreeing to participate in this study in which I am trying to find out if there is a relationship between sight-reading and sight-singing skills. You will need to sing a few melodies and play a melody on your instrument. Your performance will be recorded to ensure that it is properly scored. Keep in mind that your vocal abilities will not be scored, only the correct pitches."

"On the music stand in front of you are two folders. In the first are some sight-singing examples. I will play some chords to give you the key and starting note. You will be allowed thirty seconds to study the example. After thirty seconds, I will begin the tape, record your participant number and example number, and play the tonic chord and starting note again. Sing the example using any words or syllables you choose. You may choose whatever tempo you want and try to maintain it. If you make a mistake, try to continue to the end without stopping or starting over. Any questions?"

Repeat this process for the next sight-singing example.

"In the other folder is the sight-reading melody. You may look at it for 30 seconds. I will start the recording and state your number and instrument. You may choose your tempo, but try to play without stopping. Any questions?"

"You have completed the test. Thank you for your help today."
APPENDIX J

Scoring Guidelines

For each recording, please write the participant’s number and your score on a separate sight-singing scoring sheet.

Sight singing:
1. Award credit for each pitch sung correctly. Place a check mark on the correct pitches in the scoring sheet.
2. The first note of each melody is used as a reference. Whatever pitch the student sings is considered to be the tonic for the example.
3. Only the first attempt at a note is assessed. In the event that a student stops and repeats a note or several notes, only the first performance of each note is assessed.
4. If you feel that the student has the correct concept of the pitch, even if it is not sung completely in tune, credit is awarded.
5. For notes that are slid into or in which a stutter occurred, the main portion of the note is evaluated. If the student adjusts the pitch within the rhythmic time frame, credit is awarded.
6. If a student misses a pitch, but performs the next interval correctly, credit is awarded if a new key is established such as in the case of transposition.

For each recording, please write the participant number and your score on a separate sight-reading scoring sheet.

Sight-reading:
For each of the 28 rubrics indicate whether you agree (A, SA) or disagree (D, SD) by placing a check mark in the appropriate column.

You may listen to the recordings as many times as necessary.

---

7 From The development of an individual vocal sight-reading inventory by M. Henry, 1999, PhD Dissertation, University of Minnesota. Copyright Michele Henry (1999), Used with permission.
For each recording, please write the participant’s number and your score on a separate sight-singing scoring sheet.

Sight singing:
1. Award credit for each pitch sung correctly. Place a check mark on the correct pitches in the scoring sheet.
2. The first note of each melody is used as a reference. Whatever pitch the student sings is considered to be the tonic for the example.
3. Only the first attempt at a note is assessed. In the event that a student stops and repeats a note or several notes, only the first performance of each note is assessed.
4. If you feel that the student has the correct concept of the pitch, even if it is not sung completely in tune, credit is awarded.
5. For notes that are slid into or in which a stutter occurred, the main portion of the note is evaluated. If the student adjusts the pitch within the rhythmic time frame, credit is awarded.
6. If a student misses a pitch, but performs the next interval correctly, credit is awarded if a new key is established such as in the case of transposition.
7. If a student changes the octave, but performs the correct pitch, credit is awarded.

For each recording, please write the participant number and your score on a separate sight-reading scoring sheet.

Sight-reading:
For each of the 5 rubrics indicate whether you agree (A, SA) or disagree (D, SD) by placing a check mark in the appropriate column.

You may listen to the recordings as many times as necessary.

---

APPENDIX L

Sight-Reading Scoring Form

SIGHT - READING SCORING FORM

Participant #________

<table>
<thead>
<tr>
<th></th>
<th>SD</th>
<th>D</th>
<th>A</th>
<th>SA</th>
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</thead>
<tbody>
<tr>
<td>Good Interpretation / Musical Effect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accurate Articulation / Tone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accurate Intonation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accurate Rhythm / Tempo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibrato</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


Reimer, B. (2000). What is "Performing with Understanding?". In *Performing with
understanding: The challenge of the national standards for music education. (pp. 11 - 29), Reimer, B. (Ed.). Reston, VA: MENC.


VITA

Penka Spaulding is a native of Bulgaria where she received a Bachelor of Music degree in Music Education from the Musical Pedagogical Institute in Plovdiv. She graduated with qualifications to teach violin, ear training, and general music. After moving to the US, she received a Masters in Music Education from the University of Tennessee in Knoxville.

In Bulgaria she taught violin and general music at the elementary- and middle-school levels. In the US she has for twelve years taught middle- and high-school orchestras and general music classes. During this time she also taught private violin students. More recently, she moved her studio practice to Yamaha Music School in Knoxville, where in addition to individual instrumental instruction she is teaching group lessons in music theory and ear training.

Her interests include development of aural skills, movable- vs. fixed-do training, and the development of teaching materials and evaluation instruments. Mrs. Spaulding has authored a comprehensive method book for string instruments that incorporates music theory and ear training as an integral part of the instrumental instruction.

She can be reached at pspaulding@mindspring.com.