Florida State University Libraries

Electronic Theses, Treatises and Dissertations The Graduate School

2006

The Effect of Four Virtual Wind Ensemble Formations on Auditors' Perceptions of and Preferences for Overall Wind Ensemble Sound

Sean Patrick Murray

Follow this and additional works at the FSU Digital Library. For more information, please contact lib-ir@fsu.edu

THE FLORIDA STATE UNIVERSITY

COLLEGE OF MUSIC

THE EFFECT OF FOUR VIRTUAL WIND ENSEMBLE FORMATIONS ON AUDITORS' PERCEPTIONS OF AND PREFERENCES FOR OVERALL WIND ENSEMBLE SOUND

By

Sean Patrick Murray

A Dissertation submitted to the
College of Music
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Degree Awarded
Summer Semester 2006

The members of the Committee approve the Dissertation of Sean Patrick Murray defended on June 2nd, 2006.

Alice-Ann Darrow
Professor Directing Dissertation

Patrick Meighan
Outside Committee Member

Patrick Dunnigan
Committee Member

John Geringer
Committee Member

Clifford Madsen
Committee Member

Approved:

Don Gibson, Dean, College of Music

The Office of Graduate Studies has verified and approved the above named committee members.

ACKNOWLEDGEMENTS

A deep and heartfelt thanks goes to my wonderful family. Their support, love, and encouragement have meant everything in helping me achieve my goal. The greatest appreciation is extended to my committee for their wisdom, guidance and invaluable advice during the completion of this process: Patrick Meighan, John Geringer, Clifford Madsen, Patrick Dunnigan, and the professor directing this dissertation Alice-Ann Darrow. A special thanks to Dr. Dunnigan for encouraging me to undertake this task, professor Richard Clary for providing me with inspiration, and professor Paul Ebbers for his continued support of my endeavors. I would also like to thank my graduate colleagues for their talents and generosity, and the numerous undergraduates who have unselfishly given of their time to help me complete this dissertation.

The conclusion of this degree marks the end of a very long and fruitful association with this university. The growth I have achieved during my time here is a direct result of the quality faculty, staff, and students who have provided me with opportunities and experiences I will take with me the rest of my life. Finally, I must thank major professor Dr. Alice-Ann Darrow for her kindness, friendship, guidance, and wisdom. Thank you for showing me what it means to be a professional.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The primary purpose of the study was to examine the effect of four virtual wind ensemble formations (blocked sections, families, random and center) on listeners' preferences for and perceptions of overall wind ensemble sound. A secondary purpose of the study was to examine participants' responses under two listening conditions: headphones and speakers. Participants were music majors at a large Southeastern university ($N = 120$). Instrument sections in the university wind ensemble were recorded separately playing their part to a Bach chorale. Four seating formations were produced in a virtual environment by placing the separate audio tracks at one of five pan settings. The tracks were then mixed to produce four recordings that varied with regard to instrument section placement. Participant preferences for the four formations were determined via paired comparisons. Formation excerpts in each pair were presented simultaneously with a switching device that enabled listeners to alternate between synchronized versions of each excerpt. After listening to each pair of excerpts, participants were asked to indicate their preference for excerpt A or B or whether they heard no difference. If they preferred excerpt A or B, they were asked to indicate their degree of preference, and then the musical factor that most contributed to their response (tempo, volume, balance/blend, pitch/intonation, or tone quality). Frequency of preference responses indicated that three formations (random, families and blocked-section) were preferred significantly more than the fourth formation (center). No significant difference was found between the random, families and blocked-section formations. Results revealed that balance/blend was the musical factor that most significantly contributed to participants' preference responses. Results also indicated a significant difference between preference responses for random and blocked-section formations made under the headphone and speaker listening conditions. Implications for practice suggest that specific formations may contribute to better communication among players, and between the conductor and the ensemble, but do not necessarily influence listeners' preferences for overall sound.

CHAPTER 1

INTRODUCTION

Nothing in the natural world exists in a vacuum. Anything in one's sphere of existence constitutes environment. The American Heritage Dictionary of English Language (2000) defines environment as the area in which an object or person exists or lives. Environment can be viewed as a series of circles surrounding a central point. This type of circle is labeled "concentric," and at the center of all the circles is a person or object (Redclift & Woodgate, 2000). Realistically, the circles of influence continue for infinity, but ultimately most people are only conscious of the closest five or six layers of their environment. Naturally, one's environmental circles overlap with the circles of other individuals. These interactions between environments ultimately affect the way we relate to one another.

An important aspect of the environment is its design and the movable objects therein. An example of object influence would be to move chairs and tables closer together in a restaurant in an attempt to stimulate patron proximity and interaction. Hall (1966) labeled the architecture and objects in our environment as either "fixed feature" space or "semi-fixed" feature space. He refers to fixed feature as space organized by unmoving boundaries such as rooms of a building. Semi-fixed feature space is defined as the arrangement of objects, such as tables or chairs within a room. Hall states that both fixed feature space and semi-fixed feature space can have a strong influence on our communication behavior. The physical design and layout of an environment not only influences human interaction, but the sounds we hear within that environment.

Acoustics is the scientific study of sound, and the reaction of sound to various environments. Architectural acousticians experiment with the design of acoustical material that will produce the best possible listening experience in various environments. There are several basic facts about sound in environment. One of these facts is that the pattern of any sound that reaches the ear is different from the sound pattern at the source (Handel, 1989). From the time sound leaves its source it is reflected and scattered. The environment around the listener and the other objects in the environment ultimately affect what we as listeners hear. The other fact is that in a homogenous environment, sound waves spread out equally in all directions; thus, having important implications for the environment in which the sound is produced.

Handel (1989) illustrated the influence of environment by explaining that if two people were to stand facing each other in an open field and one person spoke, the sound would travel away equally away from the source in all directions. The listener would hear direct sound waves, as well as those waves that reflect off the ground in between the two people. If the same two people were in an enclosed room, the listener would hear the direct waves as well as the waves that reflected off all the walls, the ceiling and the floor. For this reason, many stages have back walls designed to reflect escaping sound waves back towards the audience. The results of the numerous sound waves are three-fold. The first result would be that the total energy reaching the listener would increase. The second would be that the listener would receive a sequence of different sound waves. The most direct wave would be the loudest followed by subsequent rays returning with attenuated time intervals and strength depending on the number of reflective surfaces off which they bounced. The third result of this reverberation is that multiple reflections allow for sound to reach under balconies and into different rooms. Balconies with large openings and small overhangs are part of good architectural design that will allow sound to reach all seats.

Handel (1989) also pointed out another important fact about sound. He states that the amplitude of a sound from a sound source at position A to a recording microphone at position B would be exactly the same if you reversed the position of the source and the recording microphone. This statement means that a listener will hear the same identical sound if a performer is onstage and the listener is in an auditorium seat, or if the performer is in that seat and the listener is at the performer’s position on the stage. Much of this information related to sound waves is based on only one sound source. When there are multiple sounds emanating from different sources, as in a musical setting, different factors can affect the listener’s perception of sound. One of these factors affecting a listener’s perception of sound is “space.”

The most common example of space in the environmental is personal space—the distance between people (LeBlanc, 1981). How individuals are arranged in the environment affects not only communication among them, but also the transmission of sound to them. These implications for space, communication and transmission of sound, are both important to the use of space in ensemble settings. In the natural environment, individuals tend to protect their personal space, and do not place themselves in closer proximity to each other than is needed for interpersonal communication. In an ensemble setting, performers' personal space is often compromised by formation settings based on tradition (Daugherty, 1996).

Another aspect of our surrounding environment that exerts influence on the way we communicate and hear is formation. Almost all environmental formations grow out of necessity. Sometimes the necessity is obvious and the formation that develops from it is logical. All formations have function and they are designed to address a specific need. Form and function is prevalent in everyday life. From the way a parking lot is laid out to the way the buttons on a remote control are positioned, form is almost inevitably dictated by function.

When coupled together, formation and spacing can be observed in almost every aspect of human behavior (Knapp & Hall, 2002). The use of formation and spacing in musical ensembles serves several functions. The formation of an ensemble is necessitated by a need for performers to communicate with the conductor and one another, while at the same time, communicating with the audience. The formation of a performing ensemble is also influenced by sound. Ensemble directors often place instruments or voices in different formations to produce a desired musical affect. Conductors have examined the seating formation of bands and orchestras with respect to instrument placement for hundreds of years (Koury, 1986). Ensembles' formation and spacing have been manipulated to serve a variety of functions.

Many conductors have based their particular seating formation on years of experimentation with various musical groups they have directed. Many of the different formations are based on early performance traditions dating back to the nineteenth century for both orchestra and band (Koury, 1986). The historical literature related to seating formation reveals that often the seating of performers was organized for convenience (Koury, 1986). Nineteenth century ensembles were still led by a performer playing either violin or, most likely, pianoforte; and therefore, most set-ups of this time period were designed around the piano, which was placed in the middle off the ensemble. Today's modern ensembles are led by a non-playing conductor who is the focal point around which the ensembles are seated. The ensemble is usually placed in a semi-circular formation. The reason for this placement once again relates back to the function of communication between conductor and player. The greatest variation comes in the placement of the various instruments in the ensemble, although there are many commonalities associated with different seating formations.

In most cases, directors will cite improved balance and blend as the benefits behind particular formations. The need to hear all instruments clearly is of prime importance. For many active wind conductors, the sound they are trying to attain has its foundations in a book written by Francis McBeth (1972), *Effective Performance of Band Music*, in which he describes his "sound pyramid." The pyramid idea functions on the rule that the lower your instrument tessitura, the louder you should play and vice versa. This taxonomy, in essence, puts the tuba and piccolo on opposite ends of the spectrum dynamically. This timbral organization of sound has been challenged by composers and arrangers who suggest that balance and blend in an ensemble is more a function of orchestration than dynamics (Rimsky-Korsakov, 1964).

Conductors such as Garafolo and Whaley (1976), also make reference to sectional placement decisions, such as the need for percussion to be placed in the back away from the listeners and woodwind instruments. They state that this formation helps balance and blend by allowing timbres of the different sub-ensembles, choirs, and sections to be heard. Garafolo and Whaley also advocate that all first chair players sit in close proximity so they can hear each other; and thus, solidify intonation and blend.

Other conductors change their seating formation based on the piece being performed (Curry, 1994; Renshaw, 2000). Curry (1994) advocates changes based on the scoring and melodic importance of different instruments, while Renshaw (2000) suggests a seating formation based on the style of music being played. He supports his views with historical examples of seating formations used by wind bands past and present. Several other experienced conductors have also indicated their preference for seating in a wind band setting (Begian, 1997; Gifford, 1995). Begian (1997) favors a seating chart in which instruments of similar voicings and musical line sit together and a formation in which the clarinets sit to the conductors left to mimic the placement of the violins in most orchestras. His opinion is slightly different from conductors such as Gifford (1995), who seat their groups so that strong and weak players sit near one another in an effort to improve intonation and blend. Gifford is a proponent of constant experimentation to determine where the performers will have the best balance and blend. Most of these conductor's views are unsubstantiated opinions that have been developed through personal experience.

Little empirical experimentation has been carried out to compare the sounds of instrumental ensembles in the aforementioned seating arrangements. Important to this discussion is the fact that spacing has also received little attention in the research literature. This omission is, in part, due to the fact that the desired wind ensemble sound is subjective and is dependent on factors such as numbers of performers and acoustical environments. Most research related to formation and spacing of performers has been carried out in choral settings (Daugherty, 1996; Ekholm, 2000; Lambson, 1961; Tocheff, 1990). These experiments find their roots in the choral techniques employed at schools famous for their choral tradition. One of the more notable of these institutions is the St. Olaf Choir and the choral tradition that developed under the direction of Weston Noble.

The present study stems from the author's past observations of various wind ensembles and conductors. These conductors' arrangements varied from semicircular seating to straight lines. Their ensemble formations varied the placement of individual instruments and whole sections. Conductors' various seating formations frequently share similar traits. Some of these traits include seating the tubas and percussion in the back and the flutes and clarinets in the front. The author's observations of variations in formations and spacing prompted the following questions, "What differences in the overall sound exist, if any, between these various formations?" As evidenced earlier, there have been numerous books and articles written about the seating formations of an ensemble (Begian, 1997; Curry, 1994; Garafolo & Whaley, 1976; Koury, 1986). If form and function exist in any environment, then what is the function of these various formations? What benefits do they offer to the conductor in terms of balance, blend, and overall ensemble sound?

The aforementioned questions prompted the present study, the purpose of which was to examine the effect of various band formations (blocked sections, families, random and center) on auditors' preferences for and perceptions of overall wind ensemble sound. The purpose of this study is to determine empirically what change, if any, different seating formations used by wind ensemble members for practice and performance have on overall ensemble sound as perceived by the listener.

CHAPTER 2

REVIEW OF LITERATURE

The review of literature covers empirical research as well as professional opinion publicaions related to ensemble formation. The literature reviewed also includes the topics of ensemble sound as well as preferences for and perceptions of musical sound.

Preference studies

Many of the decisions people make during the course of a normal day have something to do with preference. Some preferences are based on factors people have little control over, such as gender, height, or race. Other factors influencing preference are culture, experience, education and age. Numerous researchers have examined these factors as variables that affect preference in music. Several researchers have designed models and theories for music preference (Berlyne, 1974; Leblanc, 1980, 1982; Prince, 1972). Of these preference models, Leblanc's has been cited frequently in the study of music preference. His model incorporates variables that influence the listener's decisions in making preferential judgments. Radocy and Boyle (2003) noted that, "While the model does not predict what judgment any particular listener will make regarding a piece of music, it is quite useful in detailing many of the processes that comprise a preference judgment." (p. 372) Additional factors related specifically to a music composition, such as tempo and style, have also been examined in regard to musical preference.

Tempo. One element of music that has been examined in relation to preference is tempo. The tempo, or speed, of a musical work can influence many other elements such as style, articulations, intonation and mood. Wagner (1989) pointed out that tempo is the basis for melody in all its aspects. Many investigations have been carried out by researchers to examine the effect musical factors, such as pitch, would have on tempo preference. Geringer and Madsen (1987) investigated pitch and tempo preferences in recorded popular music by asking participants to rate their preference for a recorded excerpt that had alterations in pitch and tempo, and the same excerpt presented unaltered. In contrast to previous studies, results indicated that listeners did not show preference for faster tempi and raised pitches in recorded music. They also found that listeners' written comments dealt primarily with tempo changes.

Tempo preference has been investigated with listeners' of different ages. Leblanc, Colman, McCrary, Sherrill, and Malin (1988) investigated tempo preferences among listeners ranging in age from third grade to college. Analysis showed a significant preference for increasingly faster tempi at every age level. Their results also showed that age was a strong influence on overall preference, which was highest with the third grade listeners, declining gradually to seventh grade and then rising as age increased to college level listeners. Researchers have coupled tempo with other musical elements in examining listener preferences.

Brittin (2000) studied children's preference for various sequenced accompaniments to determine the influence of style on perceived tempo. Results indicated that there was a strong positive correlation between preference for musical styles and perceived faster tempos for third through sixth graders, though not second graders. This relationship between faster tempos and increased preference has been corroborated by other studies, (Leblanc et al., 2000; Leblanc & Cote, 1983; Leblanc & McCrary, 1983; Montgomery, 1996), and between tempo and performance medium (Leblanc et al., 2000).

Style. Music styles are derived from many different cultures and historical periods. It is this diversity that makes style an interesting area of study in relation to preference. In a study done by LeBlanc (1981), fifth-grade students were asked to take a listening test that used multiple performances set in multiple mediums and musical styles to determine their preferences. Results revealed that style significantly influenced 5^{th} graders preference and that popular music styles were most preferred. Brittin (2000) found that participants judged different songs in the same musical style more similarly for preference than versions of the same song in different styles. These two studies indicate that style has a strong influence on musical preference. Other factors that can affect listeners' preference beyond the music itself are listener variables such as age, culture, and musical training.

Age. As people grow older, their ears become more familiar with different sounds. From birth people begin to compile a library of sounds that make up the natural world. In some cases, sounds become associated with procedures and tasks that define people's environment. Sounds from an alarm clock or a siren all take on meaning. The more sounds one is exposed to, the more discerning they become in their listening preferences. One area that has been examined in relation to age is style preference (LeBlanc, Sims, Siivola, & Obert, 1996). Listeners from first grade through college and adulthood were asked to rate their preferences for 18 musical examples in the style categories of art music, traditional jazz, and rock style. Researchers found that preference means were relatively consistent across grade levels, although means varied by age. Listeners in grade one had high levels of preference for all stimulus styles. These levels declined to the lowest point for all ages in grade six. Preference levels for the various musical styles increased consistently with age through the college group before declining slightly in the adult group. Researchers have also looked at listening preferences among various age groups. Gregory (1994) examined listening preferences of high school and college musicians. Her results indicated that biases for a listener's primary instrument exist for both high school and college musicians' when asked to indicate preferences of unfamiliar classical music. Results also indicated that training broadens receptivity within and across musical genres.

Burnsed (1998) examined age and preference by investigating the effect of variations in dynamics on the musical preferences of elementary school students at two different schools. Students listened to folk songs that were either played with expressive elements, such as dynamics, or played without dynamic changes. Results indicated that a significant number of students at both schools preferred the expressive versions of six songs, and that age within the schools had no effect on preference. Flowers (1998) examined the effect of highly positive teaching presentations on participants' musical preferences for four symphonic music excerpts. She found positive instructors significantly increased participants' pretest to posttest preference ratings for all excerpts.

Leblanc, Sims, Malin, and Sherrill (1992) examined the correlation between perceived humor in music and music preference among different age listeners. They played song excerpts that were both humorous and nonhumorous. The excerpts were chosen based on, "…what we considered to be either humorous or nonhumorous orientation…" (p. 271) Their results showed that perceived humor led to significantly higher preference scores. They also found that the older the listener was, the less they perceived the intended humor, thus affecting their musical preference. Their findings related to age indicated that preference scores were highest for young listeners, lower in the middle age groups, and rose again at the college level. These findings related to age corroborate those of LeBlanc, Sims, Siivola, and Obert (1996); and Leblanc, Colman, McCrary, Sherrill, and Malin (1988). Their results also showed a decline in preference for listeners in the adolescent ages. Further research in this area seems warranted to determine factors associated with adolescence that might contribute to a decline in listening preference.

Culture. Another factor that has been examined in relation to preference is a listener's culture and background. Culture affects the environment, and thus the sounds one hears in that environment. A child who grows up in Africa will have a different set of experienced sounds than a child of the same age who grows up in Japan. Cultural differences related to country of origin, language, race and music all affect preference. If a child was taught music in the Balinese tradition, he or she might find the tuning systems of western art music to be foreign or even disagreeable. In this age of technology, our world has grown smaller. No longer is music from other countries and cultures as unknown to us. Musical styles from all over the world have experienced a fusion and music from around the world is heard in many public school classrooms. Though more familiar, differences in music of other cultures still have an effect on listener preference. Leblanc, Jin, Stamou and McCrary (1999) attempted to compare musical preferences based on age, country, and gender. They found that age, country of origin and gender were important factors in determining listener preference. Their conclusions were cautionary and indicated that trying to apply listener preference findings from one culture in an attempt to predict listening preferences of another culture was not recommended.

Killian (1990) investigated junior high school students' music preferences when they were given a choice of musical excerpts that were associated with, or perceived to be performed by musicians similar to their own race and gender. She found that students preferred music performed by artists similar to their own race and gender. McCrary (1993) also found that African-American listeners gave a stronger preference rating to music in which they identified the performers as African-American. Preference ratings given by white listeners were virtually equal for both African-American and white performers. Preference studies related to age and culture are closely tied to studies that examine preference based on listener experience and musical development.

Musicians and nonmusicians. As people age, their experiences become more varied. In the case of listeners' musical experience, many researchers have examined the differences that exist between musicians and nonmusicians. Furman and Duke (1988) examined the influence of majority consensus on music preference. They found that nonmusic majors were significantly more affected by the preference of others while listening to various recorded orchestral and popular music excerpts than were music majors. Price (1996) examined musician and nonmusician opinions related to by using both sampled and synthesizer sounds. He found that both groups' favored acoustic timbres to electronic timbres; however, musicians reacted more negatively to electronic timbres than did nonmusicians. Johnson (1996) examined nonmusicians' and musicians' ratings of a performer's decision to use rubato. In addition to rating rubato, participants in the study were asked to evaluate the performance with regard to musical elements such as expression, tone quality, and tempo. Results showed significant differences between musicians and nonmusicians in assessing the use of rubato. Results also showed that musicians' assessment of the performer's musical skill based on musical elements was in direct agreement with assessments given by a panel of experts. Hoover and Cullari (1992) also examined differences between musicians and nonmusicians. They asked musicians and nonmusicians to adjust the volume level of a musical selection chosen from ten types of music to the loudness level of a steady sustained tone. They found that musicians were less accurate in being able to match loudness levels between two different sound sources than nonmusicians. They also found that both groups were more accurate when listening to a selection that was familiar to them. Various researchers have examined other factors that can affect listeners' preference, such as modes of preference response and additional factors related to music sound quality.

Response modes. Another factor that has been investigated by researchers was the influence of response modes on listeners' preference. Brittin (1996) found that listeners using a Continuous Response Digital Interface (CRDI) rated selections significantly higher than those indicating preference using pencil and paper. This result was in contrast to an earlier study by Brittin and Sheldon (1995) in which they found no significant difference between ratings of western art music based on the response modes of Likert-scale versus the CRDI. Leblanc, Chang Jin, Simpson, Stamou, and McCrary (1998) also investigated response modes related to musical preference. Their study compared pictorial and verbal Likert-type rating scales as measures of music preference. Results indicated no significant difference between response modes for measuring musical preference, but when participants were polled a significant number of participants indicated a high preference for using pictorial scales in making preference judgments.

Response modes were also examined in a study done by Geringer and Madsen (1981). They investigated the intonation and tone quality discriminations of participants through their verbal and operant response modes. Participants were divided into three groups and asked to listen and compare several performances; however each group was given separate listening instructions. Group one was asked to listen to the performance with the overall best intonation and tone quality, the second group was asked to listen to the performance with the better intonation and the third group was asked to listen to the performance with the better tone quality. Geringer and Madsen measured their verbal responses and they observed operant behavior by recording the time spent listening to each performance. Results indicated that in all three groups, participants' verbal preferences were for the excerpts with the best tone quality and intonation. Recorded listening times for participants indicated that operant behavior was for the performance with the best intonation and tone quality. Results showed a strong correlation between operant and verbal preferences. These data suggest that participants are able to identify examples of good tone quality when presented with multiple listening examples. Factors affecting listening preference may include whether the music is performed on real or synthesized instruments, whether it was heard live or recorded; or even the recording method and equipment used for playback.

Additional factors. Other studies related to the present study examined preference when using some form of electronically altered music. Wapnick and Rosenquist (1991) sought to determine whether musicians would evaluate piano music that was sequenced through a sampling synthesizer differently than the same music recorded by professional concert pianists. Results indicated that the sequenced performances were consistently rated higher on a technical and artistic basis than commercially recorded performances by all participants. However, the participants rated the tone quality lower for sequenced performances. Results also indicated a positive correlation between the three ratings scales dealing with: technical merit, artistic merit and overall impression. Geringer and Dunnigan (2000) investigated preferences for live concert recordings presented in digital and analog format. Many aspects of their methodology were incorporated into the present study. In their study, four performance groups representing different mediums were recorded live in the same hall with the same equipment. They were then mixed to both analog tape and digital audio. The excerpts were then presented simultaneously in both analog and digital formats with an audio switch box that allowed listeners to toggle between either versions for the duration of the excerpt. Half of the participants listened to the excerpts over headphones, and the other half listened in a free-field situation over speakers. Data analysis indicated that digital excerpts were rated higher than analog presentations. Geringer and Dunnigan also found that listeners showed greater preference between digital and analog versions for excerpts played by wind band and piano than for excerpts performed by choir and string orchestra. They found no significant difference between participants listening through headphones or to loudspeakers. Although these numerous factors can affect preference response, so too can listener perception and discrimination.

Listener Discrimination

The present study asks participants to listen and differentiate between musical excerpts that are intentionally varied in regard to sound direction. In order for someone to indicate a preference they must first be able to discriminate that there is a difference (Yarbrough, 1987). The ability to hear differences in music is especially important to musicians as a part of performing. Researchers in the area of music have sought to examine many areas of music preference with regard to discrimination. Geringer and Madsen (1998) examined listeners' ability to consistently discriminate between musical excerpts that were designed to be perceived as good or bad. Traditional performance evaluation rating scales (phrasing/expression, intonation, rhythm, dynamics, and tone quality) and overall performance ratings were used. Their results showed that musicians were able to consistently discriminate between good and band performances across all rating scales. Researchers have investigated listener discrimination between music that has been varied based on several other factors such as melody (Madsen & Madsen, 2002), intensity (Geringer, 1991), tone quality (Geringer & Worthy, 1999), pitch and tempo (Brittin, 1993; Geringer & Madsen, 1984).

Madsen and Madsen (2002) conducted a study that investigated whether musically trained and untrained adults perceived melodies different than children in sixth and eighth grades. They asked each group to listen to sixteen original melodies that were followed by eight different melodies that were extremely similar. Participants were asked to perceive the target melody when the similar melodies were interjected between the original melodies and their reappearance. Although musically trained adults showed the greatest accuracy in their perceptions of target melodies the researchers showed that even young listeners have the ability to remember and identify similar melodies with a high level of accuracy.

Another factor related to listener discrimination in music is intensity. Intensity can occur through musical scoring, dynamic fluctuation, vibrato, melody and harmony. Geringer (1991) asked listeners to discriminate between musical excerpts and electronic tones that varied in intensity levels. Geringer found that subjects correctly discriminated intensity decreases sooner than intensity increases.

Brittin (1993) examined tempo and listener discrimination. She asked performers and non-performers to watch a conductor beat time while listening to a drum beat simultaneously. As participants watched and listened, either the drum beat or the conductor changed tempo. Results indicated that performers were significantly more accurate in discrimination of tempo changes. She also found that all groups discerned tempo decreases more easily than tempo increases. Other research done by Geringer and Madsen (1984) asked musicians and nonmusicians to listen to matched pairs of relatively familiar orchestral music and discriminate how an altered excerpt differed in pitch and/or tempo to an unaltered excerpt. They found that participants more easily identified pitch increases than pitch decreases. In contrast to the Brittin study (1993), they found contrasting results that show tempo increases were more easily identified than tempo decreases. Another study dealing with listener perception and tempo was done by Duke, Geringer and Madsen (1988), who compared musician and nonmusician listeners. Each listener was asked to compare two musical examples and indicate any perceived changes in pitch and tempo. Their results showed that musicians and nonmusicians responded similarly in all conditions. They also found that tempo changes seemed to affect pitch perception greater than pitch changes affected tempo perception.

Another factor surrounding listener discrimination and musical elements involves tone quality and intonation. Geringer and Worthy's (1999) study involved altering samples of individual instruments playing steady tones. The original samples were adjusted to produce a "bright" and "dark" tone. Participants were asked to listen and rate the excerpts on perceived intonation. Results indicated that inexperienced instrumentalists indicated the "brighter" tones as sharper and the "darker" tones flatter in intonation. If a performance is recorded for playback at a later time; the method by which it is recorded can have an effect on listener response. Several studies have examined variables related to recording medium and recording playback.

Principles of sound and sound technology

In the current study, listeners were asked to indicate preferences for and perceptions of sounds that were recorded, altered digitally, and played back using various forms of sound technology. Recorded sounds were altered to simulate various wind ensemble formations. In order to understand virtual sound environments, some discussion of how sound is captured, processed and played back is warranted. The following section involves a brief discussion of recording technology and the way sound is received and interpreted by our ears.

Sound Recording

Sound recording is arguably one of the single greatest accomplishments of the past 200 years. Since the day in 1877 when Edison first recorded a human voice on a tinfoil cylinder phonograph, the technology used to record and playback sounds has made great advancements. The process has improved from cylinder to record, from record to magnetic tape, and from magnetic tape to compact disc (Schoenherr, 2005). The ability to accurately capture live sounds is a continuing task that is related to human aural perception as well as to technological advancements in the areas of microphones, recording formats, speakers, and headphones.

Microphones. Microphone development has progressed drastically since the days of Edison. There are omni-directional and unidirectional microphones, stereo and monophonic microphones, and dynamic and condenser microphones. Condenser microphones are the type most commonly used when recording live sounds at a high quality. Condenser microphones use a stretched metallic diaphragm in close proximity to a metal back plate. The microphone uses very little vibratory motion and can encode sounds over a wide frequency range with a high range of fidelity. Once sound is aquired electronically through microphones, it must be stored with some type of recording device.

Recording formats. Different recording devices capture sound waves in analog formats such as tape, or in digital format such as digital audio tape, compact disc or computer audio file. Analog formats were first seen with the production of vinyl records and then with analog audio tapes (Schoenherr, 2005). Analog tapes are based on a direct electrical transfer from microphone to a magnetized tape surface. Other options became applicable in the late seventies and early 1980's with the advent of digital recording. This recording process changed in 1982 when the Sony Company released the first five-inch compact discs. Thus began a debate over digital and analog recordings.

Digital vs. Analog. It is with the move to the storage media of digital audio tapes and compact discs that recording moved from analog to digital formats. Digital recording formats incorporated the use of sampling, in which sound is sampled over a time interval. Proponents of digital music cite its reduced distortion, larger dynamic range and clearer reproduction as the reason that digital sampling has become the industry standard for modern recordings (Libbey, 1995). Research has shown that digital recordings are preferred over analog recordings in blind comparisons (Geringer & Dunnigan, 2000). Still, there are those in the recording industry who contend that analog is still superior in reproducing subtlety of expression (Liversidge, 1995). Regardless of how a sound is recorded and the technology available for storage, there remain real limitations in reproducing a sound similar to the sound one hears in a live setting.

Playback Format

In a live music setting, such as a concert hall, sound usually emanates from a source (or sources) located in front of the listener. The listener hears sound waves from the direction of the primary source as well as reflective and reverberant sounds that have been bounced off the wall, the floor and the ceiling. Researchers have sought to develop audio systems capable of reproducing these sound effects.

Spatial Audio Systems. As discussed earlier, recording microphones have the ability to record in mono or stereo format. Additional microphones can be used in addition to stereo microphones to isolate a particular musical timbre or performer. The audio industry has been able to produce spatial audio systems that reproduce stereo sound. There are three basic types of these systems: two channel (stereo), multi-channel and binaural recordings (Duda, 2000). Two-channel systems are very simple. If you want to have a sound on the left, you run the sound to the left channel. The opposite applies to right channel for sounds on the right of the listener. Using a traditional two-speaker setup, sound editing can replicate sounds from left to right using pan techniques to isolate sounds on a particular speaker. It is also possible to produce a phantom signal by sending the same signal to both left and right channels while having the listener sit directly in between two in-phase speakers. However, the phantom signal can only be heard within the direct line separating left and right speakers.

Multi-channel systems are another method of localizing sound that requires separate channels for every direction. In this format, one can manipulate sound in a controlled dimension of space (Schroeder, 1993). This audio model is the type of system that is used in most movie theaters for a surround sound effect. Audio signals are sent through a device such as a Dolby Pro Logic surround sound receiver which then sends the sound to various small speakers. This audio system has been taken further by the introduction of Dolby 7.1 surround sound in which the listeners are bombarded with sound in a near 360-degree environment.

The third type of spatial audio system is binaural recording. Duda (2000) points out that it has long been known that sound editing does not need multi-channels to create convincing three-dimensional sounds. These sounds can be accomplished by recreating the sound pressures at the right and left ear drums that would exist if a listener were actually present. This result is produced by putting two microphones in the ear canals of a mannequin and having them record sounds. The resultant effect is that when the recorded signals are run to the same channels on a pair of headphones, they produce the original sound field environment. Moreover, if the mannequin is also outfitted with the listener's pinnae, then the recording will also replicate elevation cues (Algazi, Duda, Duraiswami, Gumerov, & Tang, 2002). These methods of spatial audio all have to do with understanding how the ear is able to locate sounds.

Sound localization. Strutt was the first to work in the area of sound localization. In his book, *Theory of Sound* (originally published in 1877), he detailed, in part, the localization of sound. He observed that if a sound source is in front and to the right of the listener, then the left ear is in the shadow cast by the listener's head (Strutt, 1945). From this observation, he concluded that the sound signal would be much stronger in the listener's right ear than the sound signal in the left ear. He observed that this difference was a clue to the listener that the sound originated from the right. Strutt also noted that low frequency sounds are harder to locate than high frequency sounds because low frequency sound waves tend to dissipate around the head. These observations of sounds coupled with the precedence effect are essential to sound localization.

The precedence effect is also known as the law of first wave front (Gardner, 1968). It states that when two or more similar sounds reach a listener from different directions in quick succession, the listener will only hear the sound from the direction that first hits either ear. In other words, the first arriving sound wave, with accurate localization information, will be given precedence over all other subsequent reflections of the sound. Without this effect, sound localization would be virtually impossible. Hartmann (1983) pointed out that in live settings, sounds from the floor and ceiling help localization because they reflect sounds that point toward the source. However, sounds from the walls generate cues from different orientations and in turn hinder localization. Researchers have shown that listeners of live music prefer concert halls in which there are strong laterally traveling sound waves (Barron & Marshall, 1981; Schroeder, Gottlob, & Siebrasse, 1974). Handel (1989) suggests that perhaps, "the sense of being surrounded by the music is more important than the sense of being able to localize the instruments."

No two people hear sounds exactly the same way. This detail is partly related to the way ears receive and process sound. The shape of the outer ear affects localization and differentially affects high and low frequencies. The creases and folds of the outer ear function as means to help locate sound sources (Wagner, 1994). Sound waves that arrive from different directions are also changed by the listener's head and upper torso. This diffusion or scattering of sound has been labeled the anatomical transfer functions (ATF) or head-related transfer functions (HRTF) (Hartmann, 1999). As people get older, their brain adjusts to the way their ears alter incoming sounds waves. If one person were asked to listen via another person's ears, sounds would seem out of place (Stevens, 1998). This aspect of hearing is one factor that makes accurate sound recording and playback so difficult. These HRTFs assist listeners in resolving front-back confusion of sounds and also to determine the elevation from which a sound is coming. Research in this area has been carried out in an attempt to virtually replicate these HRTFs and understand sound localization more accurately. Researchers have used a mannequin known as KEMAR (Knowles Electronics Mannequin for Auditory Research) to help measure head-related transfer functions. The mannequin is fitted with molded silicon ears that lead into a simulated ear canal where a microphone rests for both left right ears instead of an eardrum. The use of KEMAR has allowed researchers to not only record sounds after they have traveled altered by the HRTFs, but also to examine how different pinnae affect sound waves (Duda, 2000). Researchers have sought to produce recorded sounds that more closely resemble live sounds. Many of these attempts have been successful in producing similar localization affects when played on headphones (Kistler & Wightman, 1992).

Headphones vs. Speakers. Listening to music can take place in three ways: live, free-field (speakers), or headphones. Although most listeners would agree that the best way to hear music is in a live environment, a debate still exists between free-field listening and headphones. Headphones can create a true binaural environment. The isolated sounds that are sent to the left or right channel are only heard by the respective ears. This is different from free-field listening because there inevitably is some crossover of sound waves to the opposite ear. When headphones are combined with sound recorded using the principles of HRTFs, they can produce a very realistic three-dimensional sound with just two sound sources. When using headphones, however, the sound is perceived to be emanating from inside the head. There is no stereo field out in front of you. This listening condition can produce fatigue for listeners, even with quality headphones. Researchers have developed technology based on a head-related transfer function called "crossfeed." This technology basically involves feeding an attenuated version of each channel to the other channel. It makes headphones sound more like speakers (Hartmann, 1999). Advancements in speaker technology have produced cross-talk canceling speakers that effectively deaden left/right crossover and produce what is called trans-aural stereo sounds similar to headphones (Duda, 2000).

Speakers produce a free-field environment. The sound waves produced by speakers are able to interact with the surrounding environment. Perceptions of and preferences for a musical performance can be affected by the room in which a performance is heard, be it live or recorded. This environment produces a sound field that is around listeners. Free-field listening is closer to live sound. Another difference between headphones and speakers is related to sound localization. People listening to music in a concert hall may consciously or unconsciously move their heads in an effort to hear something different or enhanced (Handel, 1989). This physical aspect is impossible with headphones, because the sound center travels with the head. Thus, the sound is always the same regardless of the head direction.

Anatomical differences between listeners and the method by which they listen can affect how sound is heard. Research related to how listeners hear and their listening preferences, in turn, influences the environment in which sound is produced. Environment in this case refers to the way live groups produce and record sound. Groups that perform live for an audience often do not have the luxury of being able to mix sound electronically into a sound that is pleasing to listeners. Because of this, ensembles such as choirs, orchestras, wind bands, or jazz bands, etc… must have a predetermined idea of how they want to sound. Musical elements such as balance, blend, intonation must be considered when preparing to perform. These concerns have led musicians to assess the overall sound of their ensemble and the means by which they may successfully produce that sound in a live environment. The present study deals with ensemble formation and its function as one way that ensembles have developed in order to resolve some of the aforementioned concerns related to live musical performances. Before discusing ensemble formations, we must initially look at the type of sound we want produced by our ensembles.

Wind ensemble sound

The wind ensemble sound, with its various timbre groups, is at its basic level different from that of a choir or string orchestra. The goal of a wind ensemble is to produce a sound that is well-balanced and blended. Unlike the choir and string orchestra, the wind ensemble must accomplish balance and blend with several different instrument groups that have differing timbres. The wind ensemble is not comprised of homogeneous timbres like those of the human voice in a choir or instruments in a string orchestra. It is this differentiation that sets the wind ensemble sound apart from these two ensembles.

Balance in the wind ensemble is defined as the strength of the various instrumental sections and the extent to which one or more of these sections tend to dominate the ensemble as a whole. A good balance will not necessarily be achieved if everyone plays at the same dynamic level. More attention may need to be given to the melody, or to some moving inner line. “Blend” has two related meanings (Gale, 2001).The first meaning refers to the process of merging instrument sounds of contrasting tone colors in such a way that they produce a new sound that is different from the sum of their parts. The second meaning refers to the point at which the sounds produced by various instruments of similar tone color merge together to form a uniform timbre such that no one player stands out from the rest. Although the wind ensemble sound is ultimately determined by conductor preference, several authors have attempted to define its characteristic sound.

Much of the wind ensemble tradition is based on a book by McBeth (1972), *Effective Performance Of Band Music*, in which McBeth describes his “sound pyramid.” (See Figure 1) The book suggests that for an ensemble to be well-balanced, the lower instruments must sound louder than the higher instruments. The reason for this suggestion relates to the tessitura in which each instrument sounds. If all instrumentalists in an ensemble play at the same dynamic level, the audience will hear the higher instruments more predominantly than the lower instruments. Hearing these higher-pitch instruments more efficiently is most likely related to human hearing characteristics. The sound pyramid concept attempts to counteract the acoustical transmission of sound in order to convey, what McBeth considers, a more balanced ensemble sound to the listener. McBeth's use of instrumental dynamics has influenced directly and indirectly many band directors, and thus the wind ensemble sound over the past 30 years. Many directors use McBeth's sound pyramid in the teaching of their musical groups. Garafolo (1996) also advocates this pyramid concept as a means to better blend, but also improved intonation within the ensemble. These concepts of overall ensemble sound have helped to change the formation in which ensembles perform. These formations not only addressed issues of clarity, intonation, balance and blend, but they also developed out of more practical needs of the ensemble (Daugherty, 1996; Koury, 1986). These needs are examined by looking at formations of three different ensemble types: choir, orchestra and wind ensembles.

Ensemble Formations

Factors related to an ensemble's sound are numerous. These factors, among others, include the type of ensemble, the piece that is being performed, the number of players, the proficiency of the players and the acoustical conditions. As mentioned before, these elements can affect intonation, blend, balance accuracy and timbre of a musical performance. Seating formation is one of these factors that can change elements of a musical performance. However, there is no agreed upon way to seat an ensemble for the best performance. In fact, there is very little empirical study of wind ensemble formations. Most literature in the area is based on opinion or history. The following literature is a review of publications based on opinion and research in an attempt to understand more about wind ensemble formation and its effect on sound.

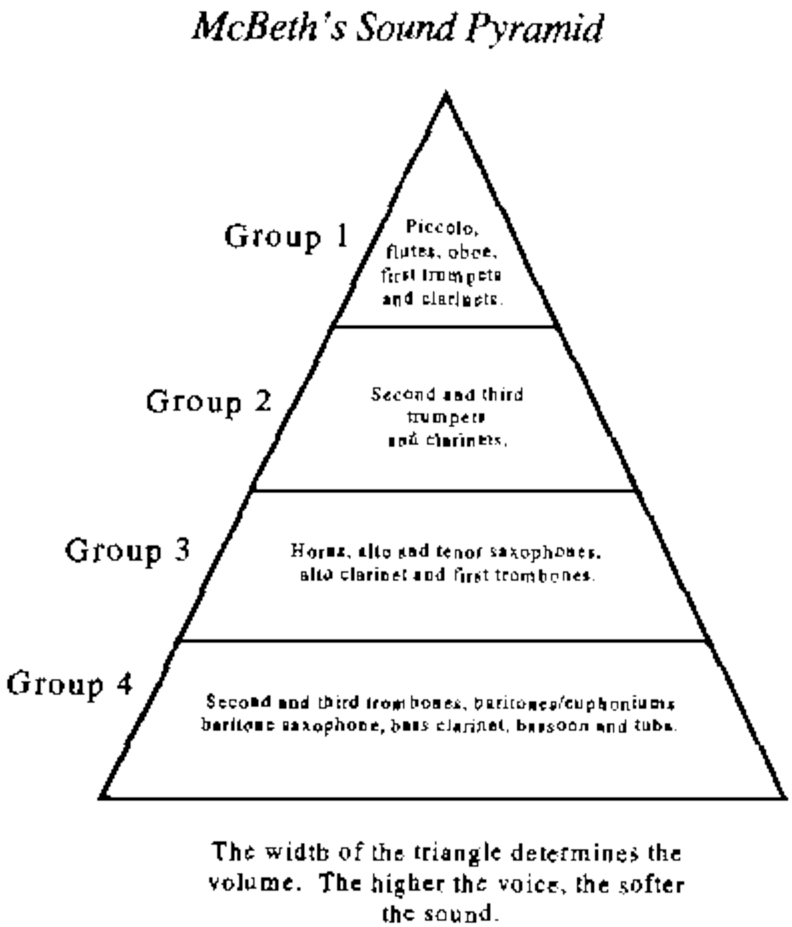

Figure 1. *Francis McBeth's sound pyramid for wind bands*

Choral formations. Most of the literature regarding ensemble formation exists in the discussions of choirs. Various professional conductors and researchers have examined differences in ensemble formation and their effect on choral sound. Many choral conductors place their singers based on several factors. Choral formation preferences can be classified into two categories (Daugherty, 1996). The first is macro-arrangement, which refers to positioning the choir and each of its voice sections as a whole. The second is micro-arrangements that deal with individual positioning of singers within the choir or voice section.

Examples of macro-arrangement can be found in Webb (1993). He advocates a sectional formation of voices because of its advantages in strengthening voice parts and improved intonation and blend. Micro-arrangement formations (W. Johnson, 1978) is the careful and purposeful placement of individual singers so that the carrying power of a particular voice is not absorbed by the surrounding voices. Similar to the timbral classification of performers in a wind ensemble, choral conductor Harold Decker classifies singers into light, medium, and heavy voices (Knutson, 1988). He places the heavy voices in the back, the light voices up front and the medium voices in the middle. Dierks (1960) expressed a different view on choral formation. He felt that the more voices resembled each other, the more they should be separated. All of these preferences are similar to many of the formations used by wind ensemble conductors. However, wind ensembles traditionally have utilized less variation in seating formations for rehearsal or performance.

Various researchers have examined the effect of seating formations on choral sound. Tocheff (1990) interviewed various conductors and found varying opinions regarding choral formations. Lambson (1961) found differences in seating that favored formations in which voices of different vocal parts were placed together throughout the ensemble. Daugherty (1996) and Ekholm (2000) examined the effects of random positioning versus acoustic formations developed by Weston Noble, and they also investigated sectional versus mixed formations. Daugherty (1996) investigated formation, and spacing of choristers and found that choristers singing in the choir preferred spread spacing. Ekholm's (2000) study in particular, compared sectional seating versus seating via Weston Noble's practices of perceptual acoustic matching of singers' voices as detailed in a study by Giardiniere (1991). Ekholm's results revealed that acoustic seating positively affected ratings of choral performance, overall sound, and evaluation of choral performance.

Orchestral formations. Today's modern wind band is a recently developed medium compared to the historical traditions of the choir and orchestra. Examining the traditions of early orchestras can provide insight into factors that contributed to modern seating arrangements. However, no empirical research could be found that examines various orchestral formations. Seating arrangements among the orchestras of the eighteenth century varied greatly. Formations were often a result of different ideals about sonority. Other factors that contributed to early orchestral seating formations were where the presiding member of the orchestra stood and what instrument he played. The keyboard player or violin player led most orchestras. The leader required visual contact with the players and the basses that often carried the beat (Koury, 1986).

Koury (1986) noted that late in the eighteenth century the classic orchestra had space between sections to produce a contrapuntal effect between parts. Koury also pointed out that while percussion and trumpets were normally placed in the back, there was no set placement for woodwind instruments. He also noted that orchestra seating formation became more set by the nineteenth century. Composers felt that the string instruments should be seated near each other in the front due to their homogeneous timbres. The placement of string instruments also has to do with the distinct design and functionality of the violin, viola, cello, and contrabass. The best example of this design function can be seen with the violin. When a violin player places the instrument under their chin the F holes face the right side of the players. The F holes are openings on a string instrument from which much of the sound energy travels. In order to have the sound of a violin project the most, the violins should be seated on the conductor's left. The wind and percussion instruments sat behind the strings in various formations that resemble the seating of today's orchestras. If one removes the strings from many of these formations, we begin to see a resemblance to presently used wind band formations.

Wind Ensemble formations. The focus of the present study involves the wind ensemble and common formations used by musicians in school and professional settings. The genre of the wind band came to prominence in the early decades of the twentieth century. During this time, numerous conductors and educators have written their opinions regarding various seating formations of the wind band. These opinions, developed over many years, are based on the conductors' performance experiences. Some musicians refer to the viewpoints on seating arrangements to be as varied as the number of conductors who have made them (Maiello, 1996). Miles (2004) points out that the variations in what makes up a wind group, is an underlying problem in deciding which seating formation will produce the best sound. The size of wind ensembles varies from one player on a part to larger ensembles such as concert bands that feature multiple players on each part.

A number of articles address considerations for how best to seat a wind group based on functionality of the ensemble and the resultant sound that is produced. Kruth (1996) stated, “A major objective is to arrange players so that they will be heard in the most equitable balance while still able to play naturally and comfortably and with utilization of their best possible quality of sound.” (p.46) He advocates for the placement of instruments in such a way that they can be heard in the balance of the overall sound, without being placed in a situation where they are forced to over blow their instrument to be heard. Over blowing would in turn affect the players’ intonation or tone quality. This premise was reinforced by Hunsberger (1985) who observed that a good seating formation can help to improve clarity and the variety of individual instrument colors heard by listeners. He reinforced the idea that a seating formation is best when both knowledge of the players and knowledge of the performing venue are taken into account. Hunsberger, however, did not suggest that a conductor should change seating formations for every piece. He instead pointed out that any change that is made should be to produce a precise musical effect. Gifford (1995) examined several different seating formations used by prominent conductors and their views of the related benefits to ensemble sound. One of these conductors was Lucien Calliet, former educational director for G. Leblanc Corporation, who suggested placing the clear brass (cornets, trumpets, and trombones) together; the mellow brass (horns, baritones and tubas) together; and keeping both of these groups close to each other. Calliet also supported grouping low brass instruments to help strengthen the bass line and to darken the low brass tone. Gifford also examined the seating formation used by former University of Illinois director of bands, Mark Hindsley. Hindsley offered several different variations on a set formation. Each variation offered different advantages related to ensemble balance, but in all the formations he makes an effort to seat similar woodwind and brass voices nearby. Gifford also offers examples of seating charts by other prominent music educators. His review of these formations found that variations are based on similar balance and intonation objectives, and voicing placements in which instrument sections are kept together.

Page (2004) also advocated a seating formation in which families of instruments are kept close together. He contended that ensembles that use unconventional setups in which instrument families are separated tend to have a greater number of balance and intonation problems. An example of separation of instrument families as suggested by Page would be exemplified by a formation in which the bass clarinets were placed next to the trombones, because they both play in the lower register. Such placements result in the loss of the bass clarinets' timbre in the overall sound of the ensemble. Page felt that, in a wind group, when instrument families are separated and placed with instruments of similar voicings the distinct color of the varied instruments is lost. This formation produces less clarity and distinctive color that is common to the wind band.

Page also pointed out similarities between common wind band formations and orchestral seating formations. He noted that essentially the woodwinds substitute for the strings and the brass fill out the back of the ensemble. The main difference lies in the fact that the homogeneous sound of the strings are being replaced by numerous instruments of varied timbres. The view of keeping instrument families is in direct contrast to views by Cooper (2004). In his article, Cooper suggested keeping sections that play similar parts together (bass clarinets near bassoons and baritones saxophones).

Colwell and Goolsby (1991) stated that "good" formations are based on considerations of appearance, balance, precision, and practicality. They also noted that good formations are the product of a conductor who understands the group they are conducting. They suggested placing weaker sections in areas where they can be heard and placing strong sections in areas were they can be subdued. Colwell and Goolsby referred to weaker instruments as those whose sound radiates around them such as clarinets and stronger instruments such as trombones and horns and those whose sound is directional. Cooper (2004) and Hindsley (1976) both agreed that the directional properties of sound must be considered when seating instrument sections, noting that softer instruments need help in being heard. Hindsley and Cooper felt that instruments with a smaller dynamic range must be given a seating advantage. Cooper pointed out that when directional instruments like trumpets are placed in the center, their sound is more unfiltered, and subsequently stands out. When placed on the side in a semicircular band seating, their sound travels across the band and makes for a more blended overall ensemble sound. Miles (2004) quoted Myron Welch, the director of bands at a large college, who stated that he preferred trombone and trumpet be placed on the side in a semicircular band seating. Welch found that forward facing brass can easily overpower the woodwind sound making the overall ensemble sound "too edgy." This view again refers back to the idea of seating instruments according to design and function of particular instruments. Assessing instrument sections individually provides information for their placement within an ensemble.

Specific instrument considerations. Each instrument has specific characteristics that influence its sound, dynamic range and timbre. It is important to understand each instrument separately in order to place them in an ensemble setting. Placement of instruments begins with the flute family. Some seating formations of college and professional wind ensembles place the flutes on the left or in the center with the principal player seated on the far left (Miles, 2004). This formation is so that the sound hole on the principal flute can be heard by the section more easily. Other variations still put the flutes on the left, but seat the principal player in the center for ease of listening and to be in close proximity to the section on the right which is usually the oboes or clarinets (Bourgeois, 1988; Garafolo & Whaley, 1976). The clarinet is a non-directional instrument so its placement is more varied between left right and center; however, it most often found in the front closest to the audience due to its dynamic range. Double reeds are distinctive in that both oboes and bassoons have unique timbres. Although the oboe projects louder than the bassoons, both instruments have a limited dynamic range and therefore are usually placed in the front of the ensemble on the right. The saxophone family, like the clarinets, covers a large pitch range. Miles pointed out that many composers write for the saxophone as a family and they should sit together. Saxophones are also in a similar voicing as the horn. Most formations find both horn and saxophones sitting close with the section often on the right of the ensemble. This discussion then leads to one of the most debated instruments —the horn.

The horn is a complicated instrument for many conductors to place due to the directional nature of the bell. The horn projects sound in the opposite direction from the forward orientation of the player. Some conductors prefer to have the horns placed in the center so their sound will bounce off the back wall and into the audience. Most modern orchestras have the horn in the last row and very close to the back wall (Koury, 1986); however, this placement is usually not the case in most wind bands. Often a centered horn sound blows directly into the sound of forward facing brass like the trumpets or trombones. This placement prevents the horn timbre from escaping the stage. Because of such instrument characteristics, a number of authors have expressed their opinion on horn placement. Colwell and Goolsby (1991) suggested the horns be placed on the right so their bells are not facing the audience. Page (2004) liked the centered orchestral placement of the horns because he felt that if they sit on the sides, their sound projects too much and causes balance issues.

Martin (1984) interviewed seven prominent conductors about horn placement. He found that most conductors placed the horns in the center. Another author advocated a left side placement of the horns seated in two rows (Hilliard, 2004). This placement of the horns was suggested because it allows all the horns to hear one another more clearly due to proximity of each player's bell.

Trumpet, cornet and trombone seatings need to be addressed together because they are all directional instruments. The conductor must seat these instruments with a determination as to whether they want a directional or nondirectional sound. This fact makes their placement very subjective. The euphonium is not as directional as the trombone, but they share a similar range. The euphonium is commonly placed in between the tubas and trombones, or next to tenor sax and low woodwinds (Miles, 2004). Tuba finds its placement most often in the center so that the ensemble can easily hear and adjust balance. It also is placed on the right in an effort to have the sound project out into the audience. This detail is especially true when playing in a venue with no acoustic shell to prevent the sound from going straight up.

The final instrument section sound in wind band compositions is the percussion section. It tends to be uniform in its placement among wind bands and orchestras. Its placement in the back of the ensemble is due to the large dynamic range that is capable of being produced by percussion instruments and that players must move around to different instruments. The percussion is usually grouped into several categories. The basic choir consists of bass drum, snare drum cymbals and timpani. The accessories choir consists of instruments such as the triangle, woodblock and claves. The keyboard choir consists of instruments such as the xylophone, chimes and glockenspiel (Garafolo & Whaley, 1976). Many seating formations place the basic choir in the center so it is buffered and heard by the entire ensemble. The keyboard group is often placed closest to the front so that the timbral qualities of these instruments are heard. The accessories group usually finds a place between these two groups, because they are often not played as consistently and are therefore covered by players in the other two choirs.

Colwell and Goolsby (1991) pointed out that the acoustics of the performance venue can affect seating plans. If an ensemble is performing in a hall where there are curtains, the conductor must know that sound sent toward the curtains will be absorbed. This environment or concert hall is in contrast to one that has an acoustic shell to help instrument sound project into the audience. Curry (1994) suggested seatings based on several basic principles. He based his seating around the overall sound he wants to hear on a particular piece. For a contemporary piece, he suggested placing the brass, woodwinds, and percussion in adjacent blocks to emphasize the choir sound. He also stated that one must consider placement of the horns so that they are a bridge within the ensemble between the woodwinds and the brass. This same seating is referred to by Smith (1988) who uses this instrument family seating as a full time formation. Like Curry, he preferred the woodwinds and brass sit separately with the horns seated in between as a pivot group that can adhere to either family as it commonly used for both woodwind and brass quintets.

Garafolo and Whaley (1976) approached wind ensemble seating from the view of the composer, who they believe would consider the individual and combined tone colors present in the medium for which they are composing. In their article, they designed a seating chart around tone color and instrumentation. They divided the wind ensemble into sub-ensembles (woodwinds, brass, and percussion) that divide into choirs (single reeds, double reeds, bright brass, mellow brass, basic percussion, mallet percussion and accessories). They then break down choirs into individual instruments. Garafolo and Whaley assigned each sub-ensemble a power rating, though this power rating has no empirical basis. The percussion received the highest rating, followed by brass and woodwinds. This power rating determined general placement in the ensemble. Percussion is placed in the back away from audience members, and the woodwinds are placed up front. They viewed this instrument placement as a means to achieve a balanced sound and allow the timbres of the different sub-ensembles, choirs and sections to be heard. Both authors admitted that this seating is not the best seating for every ensemble, but they do believe their method is a logical compromise. They also recommended placing principal chair players together so that they can hear each other better and thus match style dynamics and phrasing. This concept of keeping principal players in the center has been used by other conductors as a means to provide clear line of sight to the conductor, and for ease of listening (Bourgeois, 1988). Central placement of principal players is in contrast to some conductors who feel the principal players should be placed on the outside in sections seated on the sides of a seating formation (Cooper, 2004). The outside placement keeps the strongest players' sounds from getting buried within the section. It also ensures that the audience will be more likely to hear the most accomplished players.

Need for the Study

There are numerous other examples of seating preferences used by prominent conductors and ensembles around the country. Each one is specific to the conductor, the venue in which they perform and the repertoire they perform (Renshaw, 2000). Renshaw (2000) presented several different seating charts used by the Sousa band, the modern U.S. Marine Band, the British military band, and the Tokyo Kosei wind ensemble. The formations were diverse and each one is based on specific factors related to each ensemble. The end goal must be to find a seating arrangement that is going to accomplish as many musical goals as possible. Renshaw's examination of ensemble formation continues to support the view that no seating is the same for every ensemble because each ensemble is different and every ensemble has different factors that affect its overall musical sound. What remains absent from such approaches is empirical evidence to support the authors' conclusions. Daugherty's (1996) study of choral formation and spacing is the primary empirical study found in relation to ensemble formation. His results showed that formation had little difference in auditor preference and perceptions of choral sound. However, the need for empirical data that parallel Daugherty's findings with choir is necessary for an ensemble type that is comprised of non-homogeneous timbres. Similar to Hunsberger's (1985) view on seating, it is not the intention of this study to produce a seating formation that could be used universally by any wind ensemble. The hope is to, instead, understand more of what is perceived and preferred by listeners and in turn identify empirical methods to assess the vast array of opinions.

Purpose Statement and Research Questions

The purpose of this study was to empirically investigate the effect of various wind ensemble formations (blocked sections, families, random and center) on listeners' perceptions of and preferences for overall wind ensemble sound. The importance of this study is to determine empirically what change, if any, different seating formations used by wind ensemble members for practice and performance have on perceived overall sound. The research questions were:

1. Do listeners perceive differences among recordings in which wind ensemble sections change position?
2. Do listeners have a preference for specific wind ensemble formations?
3. Which musical factors most influenced listeners' preference for four virtual band formations (blocked sections, families, random, or center)?
4. Do preferences for overall wind ensemble sound differ when stimulus excerpts are heard via headphones or in a free-field listening environment?

CHAPTER 3

METHOD

Participants

The listeners in this study, hereafter referred to as auditors, were college music majors from a large Southeastern university (N = 120). The college level auditors were comprised of both undergraduate (N = 93) and graduate (N = 27) students. Auditors were both male (N = 72) and female (N = 48) and ranged in age from 18-37 years. The average age of participants was 22 years. All participants indicated that they had been in a wind ensemble for at least two years between their first years in high school to the time of the study. Subjects were solicited to participate in this study by the experimenter via music classes and ensemble rehearsals, and specific dates and times were pre-established for sign-up and participation. All auditors participated voluntarily.

Ensemble Formations

Four audio recordings of the same piece were manipulated using *Soundforge* and *Adobe Audition* software to produce the effect of instrument groups sitting in different formations. These computer software were used to reproduce four different formations for band in a virtual environment: blocked section, random, families, and center.

Ensemble Formation. Four different virtual formations were used in this study. All the formations were limited to a 180-degree radius semicircle and were designed as follows:

(1) Blocked Section—instrument sections were arranged with all members of a particular section seated together in a designated place. Section placements from left to right were designed to replicate the seating formation participants traditionally use in their ensemble. This formation is common among high schools and colleges (See Figure 2).

(2) Random—instrument sections were placed in random order from left to right. This formation was determined by assigning each instrument section a number and then using a random number generator to place the sections within the virtual seating arrangement (See Figure 3).

(3) Families—this arrangement placed instruments of similar instrument families (woodwinds and brass) together with the woodwinds all seated right of center and the brass all seated left of center (See Figure 4).

(4) Center—this formation had all instruments placed in the center in the virtual listening environment (See Figure 5).

The use of virtual seating formations allowed for four recordings that were identical with regard to tempo, intonation, articulation, and dynamic contrast. This uniformity reduced the likelihood of performer differences in recordings that may have produced confounding variables.

Evaluation Measures

Evaluation methods used in this study consisted of auditors' preference and perception assessments of the wind ensemble in the four seating formations. The auditor group was asked to indicate preferences for and perceptions of the overall ensemble sound of the various formations from the listeners' perspective. Auditors were asked to listen to paired recorded excerpts of the wind ensemble in various virtual seating arrangements. They were asked to indicate a preference for each set of paired excerpts, and to indicate to what degree they preferred one excerpt over the other excerpt. They were also asked to indicate what musical factor, if any, contributed most to their preference. (See Appendix C)

Preparation of Materials

Musical Stimuli

The musical stimulus was *Wie shoen leuchet der Morgenstern* from the collection of Sixteen Chorales by Johann Sebastian Bach, compiled and arranged by Mayhew Lake (G.Schirmer, Inc., 1938). A panel of five experts was given three compositions and asked to indicate which composition they felt would be most ideal in determining differences in overall ensemble sound. Panel members all chose this chorale as the excerpt most ideal in determining differences in overall ensemble sound. This piece was selected for its rhythmic structure and layered textures of brass and woodwinds. The piece is also scored *tutti* throughout and features all the instruments of the wind ensemble. The excerpt used in this study was fourteen measures in length which approximated 60 seconds when performed.

Conductor Video

In an effort to control for possible conductor related deviations in the production of stimulus recordings, a video of the conductor was produced. The tape contained a video recording of a conductor, conducting the entire length of the excerpt to be played by the performing ensemble. The video was shot in the same performance space the performers used to rehearse and record the excerpts. It was then transferred to DVD to eliminate the time it would take to rewind a videotape. This video was played on a television placed five feet in front of the performers. The performers were expected to follow the conductor in the same manner they would follow a live conductor. This video was used to help limit recording deviations related to tempo, style, and dynamics. It was also used to produce tracks for each instrument group that would align in a sound-editing program and result in a single track that simulated an ensemble playing together in full performance.

Recording Procedures

The ensemble used to record the musical stimuli was an intact curricular wind ensemble at a large Southeastern university. The ensemble was comprised of 47 woodwind, brass and percussion instrumentalists. The ensemble was made up of graduate (N = 27) and undergraduate musicians (N = 20) both male (N = 32) and female (N = 15), and represented the following disciplines: music therapy, music education-instrumental, musicology, and music performance (wind and percussion). The breakdown of members by instrument is shown in Table 1. The ensemble performers were comprised of personnel decided on through auditions prior to the beginning of the academic semester. They were all of comparable musical ability and ranged in age from 19 to 35 years of age. Years of experience on their primary instrument ranged from 9 to 17.

The soprano, alto, tenor and bass lines of the chorale were assigned by Lake in his arrangement to a section in the woodwind family. The same assignments were made within the brass to ensure that each chorale line was represented in both instrument families. During the recording session, each instrument section was recorded separately from the rest of the ensemble on their individually assigned part. Prior to the recording session, the entire ensemble tuned their instruments and then played the musical excerpt twice as a group while watching the conductor video. This practice procedure was done to allow the ensemble an opportunity to become familiar with the conductor video. Using the conductor video, each instrument section practiced then recorded their part three times. This protocol allowed for multiple takes from which the researcher could choose the best performance. All recordings were made in the same venue on the same day. The venue was a large rehearsal hall on the campus of a Southeastern university. One stereo condenser microphone was used for the recording of all stimuli. The microphone was a Sony ECM-MS907 One Point Stereo Microphone. The microphone was unidirectional with a directive angle of 120 degrees. Each instrument section was placed in straight parallel rows seated ten feet from of the microphone.

Table 1.

Wind ensemble instrumentation sorted by instrument group

Instrument	# of participants
Flutes	5
Oboe	3
Bassoon	3
Bb Clarinet	7
Bass Clarinet	1
Alto Saxophone	4
Tenor Saxophone	1
Baritone Saxophone	1
Bb trumpet	5
Horn in F	5
Trombone	3
Euphonium	2
Tuba	2
Percussion	5

The microphone was placed on a floor microphone stand. The microphone ran directly into a laptop computer running the sound-editing program *Soundforge*. The only adjustment made in the program was input adjustments to ensure good recording levels. The input sound levels were the same for all recordings. Once these levels were set, nothing was altered during the recording process. The television playing the conductor video was placed directly behind the microphone so that all performers could easily view the screen. The performers were prompted to turn their attention toward the conductor on the videotape to record the excerpt. The conductor tape provided all entrance and release cues. At the conclusion of each recording, the researcher stopped the video and set it back at the beginning. Each recording was saved as a separate aiff. file. Upon completion of the three recordings, the performers were asked to leave the rehearsal hall.

Stimulus Recordings

Stimulus Tape. Once all instrument sections had been recorded, the audio takes were opened using *Soundforge*. The total number of separate audio tracks was ten. Each track was first normalized to its maximum peak value. The recordings were then edited so that each track began and ended at the same time. To do this edit, each raw recording was marked at the beginning of the initial waveform. The audio preceding the marker was then deleted and two seconds of silence was added to each recording. The chosen audio recordings were then opened inside the software program *Adobe Audition*. Each instrument section was given its own audio track. The waveforms were then lined up. The resultant sound file was an audio excerpt of the selected chorale played by the entire ensemble, but individually tracked by instrument section.

This composite audio track served as the basis from which to produce the four virtual formations used in the study. The first stimulus recording was made to replicate a blocked section seating formation, similar to the formation used by the ensemble members during their rehearsals and performances (See Figure 2). This virtual formation was achieved by adjusting the pan knob in *Audition* for each of the ten tracks either left or right, so that the sound for each section would come from different spatial directions. The range for the pan knob on both sides of center was 100 clicks for left and right channels. In order to keep a similar framework for all seating formations, the pan range from left to right was divided into five points. Instruments in all seating formations were placed at one of these points to produce the four seating formations. The five points were: (1) left 100, (2) Left 50, (3) Center 0, (4) Right 50 and (5) Right 100. This same panning technique was used to produce the “random” (See Figure 3), “families” (See Figure 4), and “center” formations (See Figure 5). Once adjustments were made for each formation, all the tracks were mixed down into a single stereo wav file and added to a playlist on two *Apple iPods*.

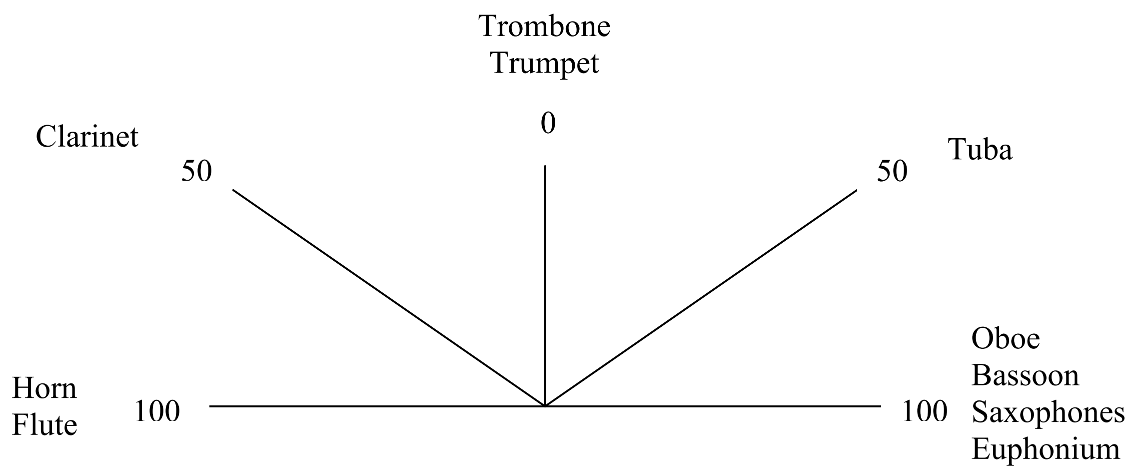

Figure 2. Pan settings for blocked-section seating formation excerpt

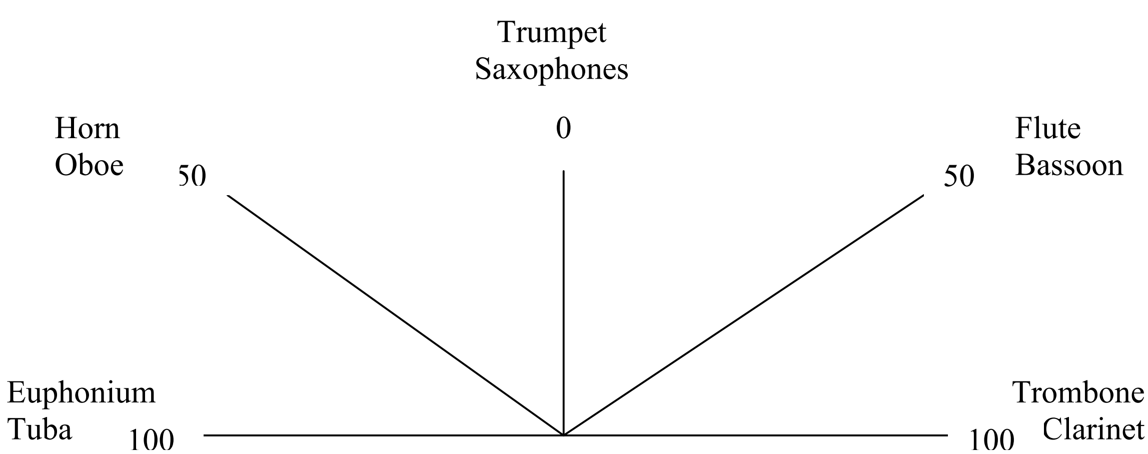

Figure 3. Pan settings for random seating formation excerpt

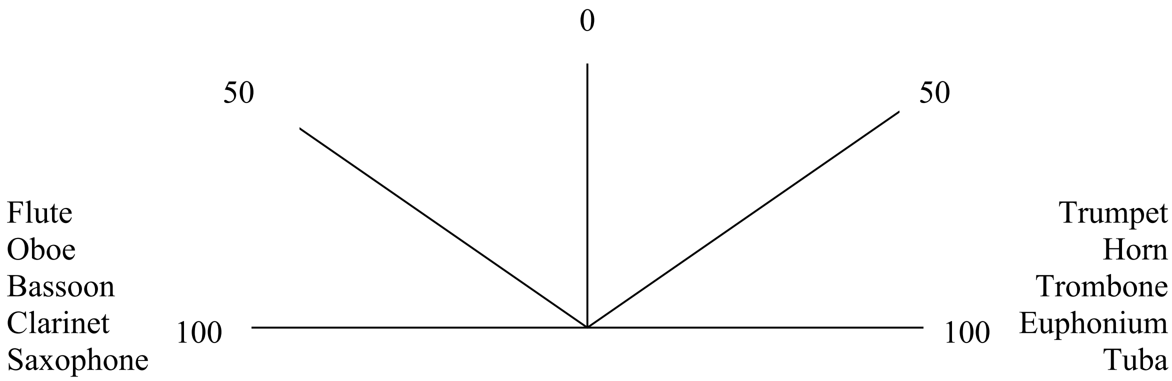

Figure 4. Pan settings for families seating formation excerpt

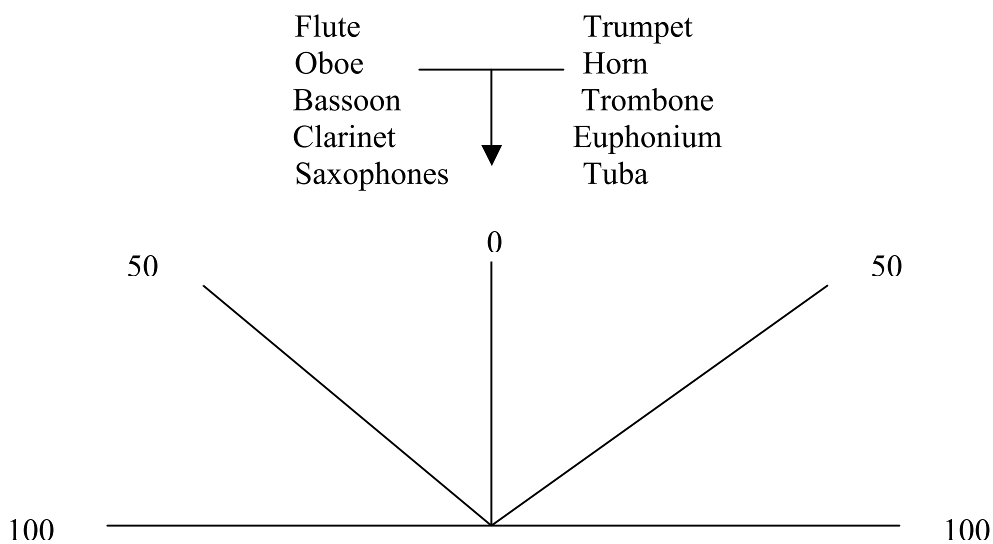

Figure 5. Pan settings for center seating formation excerpt

Presentation and order. The evaluation method used was paired comparisons. This evaluation method was used so that auditors only made comparisons between two versions at one time. In order to compare the four formations, the following pairs were used: (a) blocked section vs. random (b) random vs. families; and (c) families vs. center, (d) center vs. blocked section, (e) families vs. blocked section, (f) random vs. center. The order of comparisons was:

1. blocked section vs. random
2. random vs. families
3. families vs. center
4. center vs. blocked section
5. random vs. center
6. families vs. blocked section

Playback equipment. The playback of the stimulus recordings took place from two *Apple iPods*. Both *iPods* ran into an A-B audio/video splitter so that individual auditors could switch back and forth between the paired audio excerpts. Auditors in the headphone group listened to the excerpts via a set of Sennheiser HD 580 professional headphones. The speaker group listened to the playback via *M-Audio Studiopro 4 speakers*. Volume levels were set from the iPod and could not be controlled by auditors. A pilot group was tested prior to this stage to determine comfortable output levels.

Playback environment. Auditors completed the listening portion individually in an isolated music room. The room had no windows and was free from outside sounds.

<u>Auditor procedures</u>

Auditors were randomly assigned to either the headphone or speaker listening condition. All auditor procedures were carried out individually. Before the listening portion of the study, each auditor was asked to complete a brief form asking for demographic information such as age, gender, teaching and musical experience. They were asked to indicate whether they had ever been told they had a hearing loss. For those in the headphone group, they were then instructed to put on their headphones. Auditors read along as the instructions were read aloud (See Part 1 of Appendix C). The formation excerpts in each pair were played simultaneously. The use of identical iPods for playback helped to ensure a near seamless synchronicity between the paired audio excerpts. In order to more easily make comparisons, each auditor was given a two-channel audio switch box that allowed them to toggle between the two excerpts.

Following each of the six pairs of excerpts, auditors were asked to indicate their preference for excerpt A or B or whether they heard no difference. If they preferred excerpt A or B, they were asked to indicate their degree of preference, and then the musical factor that most contributed to their response. Participants were asked to choose among five musical factors. The musical factors listed were: balance/blend, pitch/intonation, tone quality, tempo and volume. Although tempo and volume were controlled for in the recording procedures, these musical factors were listed as possible choices to allow for more varied participant responses and to serve as foils. The response form can be found in Appendix C

CHAPTER 4

RESULTS

This study was designed to examine the effect of various virtual wind ensemble formations (blocked sections, families, random and center) on auditors' perceptions of and preferences for overall wind ensemble sound. This chapter includes the statistical data and summaries of analyses used to address each research question.

Research Question One

Do auditors perceive differences among recordings in which wind ensemble sections change position?

The four formation excerpts were paired with each other resulting in six sets of two excerpts, with each excerpt labeled A or B. The six sets of excerpts allowed every excerpt to be compared to every other excerpt. Auditors indicated a preference for either excerpt A or B in each pair, or they indicated that they heard no difference between the two excerpts. To address this research question, data under the two listening conditions were combined. Preference responses for either excerpt A or B indicated the auditor perceived a difference in sound between the two excerpts; therefore, the sum of responses for A and B excerpts in all pairs (n = 652) was compared to "no difference" responses (n = 68) using a Chi-square analysis. Combined preference responses for both A or B excerpts were significantly greater than "no difference" responses χ^2 (1, N= 720) = 472.06, $p < .05$. Of the total 720 responses, 91% of those responses indicated that there was a difference between excerpts that varied instrument section position. These data indicate that auditors were able to perceive differences among recordings in which wind ensemble sections changed position. In Table 2, it should be noted, that while not significant, "no difference" responses were greater than preference responses for either excerpt A or B in the first group of pair six. This pair compared the families formation to the blocked seating formation. These data indicate that auditors were less likely to perceive a difference when comparing these two formations.

Table 2

Preference responses given for matched pairs in both listening groups.

Matched formations	Excerpt	Headphones	Speakers	Total
Blocked vs. Random				
	Blocked-section	10	33	43
	no difference	7	2	9
	Random	43	25	68
Random vs. Families				
	Random	28	31	59
	no difference	7	3	10
	Families	25	26	51
Families vs. Center				
	Families	52	49	101
	No difference	2	3	5
	Center	6	8	14
Center vs. Blocked				
	Center	8	9	17
	No difference	1	2	3
	Blocked	51	49	100
Random vs. Center				
	Random	47	49	96
	No difference	3	4	7
	Center	10	7	17
Families vs. Blocked				
	Families	15	30	45
	No difference	26	8	34
	Blocked-section	19	22	41

<u>Research Question Two</u>

Do auditors have a preference for specific wind ensemble formations?

For each formation an overall sum of preference responses was calculated, a final preference rank order of the four formations was determined and is reported in Table 3. Subsequent Chi-square analyses of this overall preference rank shows significance between the blocked-section and center formations χ^2 (1, N= 232) = 78.56, p < .05. All other analyses of overall frequency responses yielded no significant differences. Grand means and standard deviations of auditors' degree of preference for the four ensemble formations were also computed (See Table 4). Although all means were very similar, the order of formations based on degree of preference were the same as the rank-order for preference responses. A further analysis was then done to investigate whether preference responses between formations differed when they were compared within the six stimulus pairs. For each of the six pairs, preliminary Chi-square analysis was carried out to determine differences among the three possible responses (A, B, "no difference"), with no regard to listening conditions. A follow up Chi-square was carried out using only preference responses for either A or B excerpts. Results of these formation analyses are reported in the following sections.

Table 3
Rank-order of overall preference responses for all virtual seating formations.

Formation	Frequency
Random	223
Families	197
Blocked	184
Center	84

Table 4
Grand means and standard deviations for degree of preference responses in all virtual seating formations.

Formation	Grand Mean	SD
Random	2.64	.206
Families	2.56	.473
Blocked	2.51	.189
Center	2.26	.153

Blocked-section vs. Random formation. In pair one, the blocked-section formation was compared with the random seating formation. Figure 6 shows that overall

36 % (n= 43) of auditors preferred the blocked-section excerpt, 57 % (n= 68) preferred the random excerpt and 7% (n= 9) heard no difference. The blocked section formation had a mean score of 2.65 and a standard deviation of .973. The random formation indicated a mean preference rating of 2.72 with a standard deviation of 1.14 (See Table 5). A Chi-square of the three response choices (A, B, "no difference") revealed a significant difference between the blocked section excerpt, the random excerpt and the indication of no difference χ^2 (2, N= 120) = 43.85, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up Chi-square was computed. These analyses revealed no significant difference between responses for blocked section or random formation χ^2 (1, N= 111) = 5.18, $p > .05$, therefore indicating that significant differences existed between the "no difference" response and preference responses for either excerpt A or B.

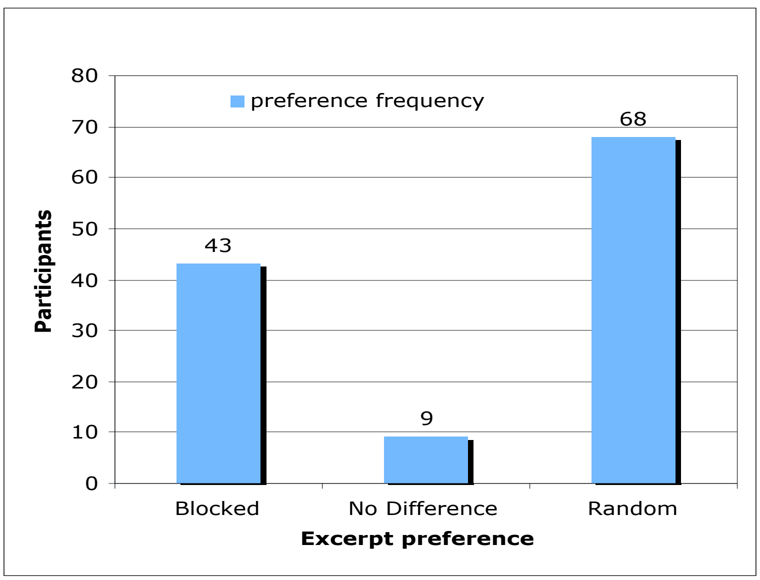

Figure 6. *Blocked-section vs. Random preference responses for all participants*

Random vs. Families formation. In pair two, the random formation was compared with the families seating formation. Figure 7 shows that overall 49 % (n= 59) of auditors preferred the random-section excerpt, 43% (n = 51) preferred the families excerpt and 8% (n= 10) heard no difference. The degree of preference was indicated on a Likert-type scale from 1 to 5. The random section formation had a mean score of 2.41 and a standard deviation of 1.18. The families formation indicated a mean preference degree rating of 2.4 with a standard deviation of 1.04 (See Table 5). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the random excerpt, the families excerpt and the indication of no difference χ^2 (2, N= 120) = 34.55, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up Chi-square analyses was computed. These analyses indicated no significant difference between responses for random or families formation χ^2 (1, N= 110) = .44, $p > .05$, therefore indicating that significant differences existed between the "no difference" response and preference responses for either excerpt A or B.

Table 5.
Mean and Standard deviations for degree of preference ratings of matched formation pairs.

Pairs		Mean	Standard Deviation
1	Blocked-section	2.65	1.03
	Random	2.72	1.14
2	Random	2.40	1.18
	Families	2.40	1.04
3	Families	3.10	1.13
	Center	2.40	1.04
4	Center	2.10	1.20
	Blocked-section	2.60	0.75
5	Random	2.80	1.23
	Center	2.30	1.30
6	Families	2.20	1.20
	Blocked-section	2.30	1.10

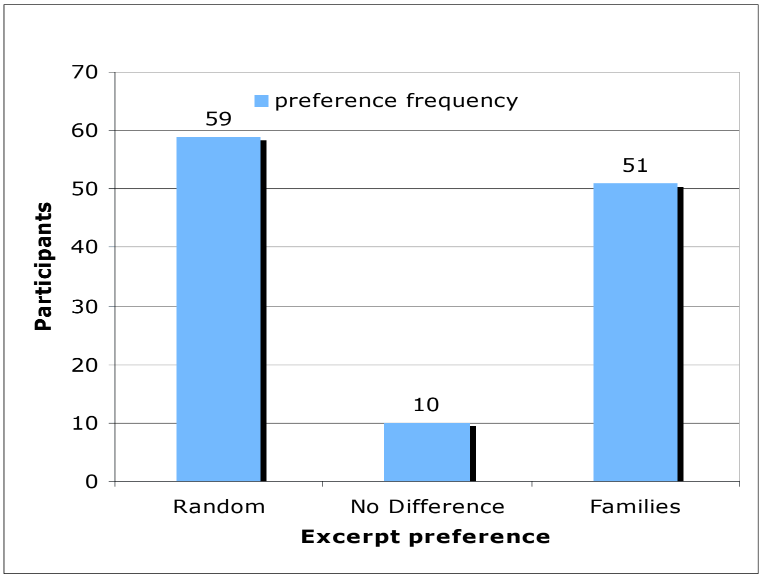

Figure 7. *Random vs. Families preference responses for all participants*

Families vs. Center formation. In pair three, the families formation was compared with the center seating formation. Figure 8 shows that overall 84 % (n =101) of participants preferred the families excerpt, 12% (n=14) preferred the center formation excerpt and 4% (n=5) heard no difference. The families section formation had a mean score of 3.1 and a standard deviation of 1.13. The center formation indicated a mean preference rating of 2.4 with a standard deviation of 1.04 (See Table 5). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the families excerpt, the center excerpt and the indication of no difference χ^2 (2, N= 120) = 140.55, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses revealed a significant difference between preference responses for the families and center formation χ^2 (1, N= 117) = 64.32, $p < .05$, thus indicating that the families formation was preferred significantly more than the center formation.

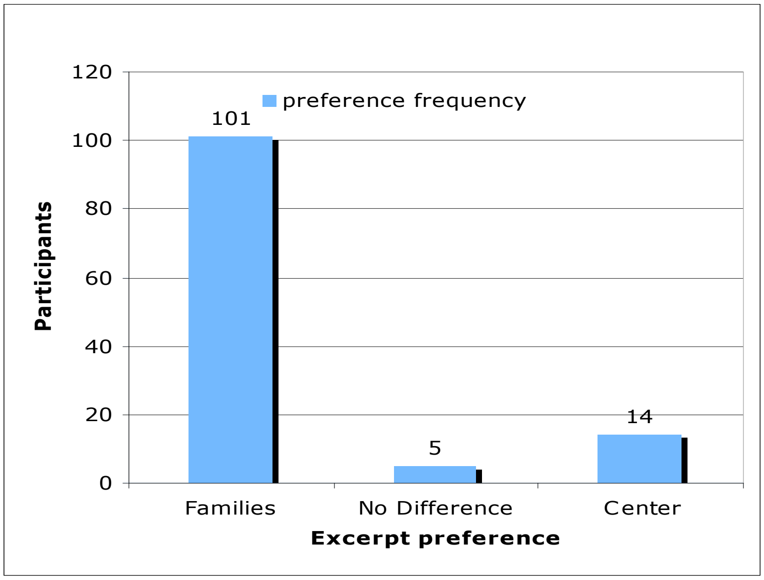

Figure 8. *Families vs. Center preference responses for all participants*

Center vs. Blocked-section formation. In pair four, the center formation was compared with the blocked-section seating formation. Figure 9 shows that overall 14 % (n =17) of participants preferred the center formation, 84% (n=100) preferred the blocked-section formation excerpt and 2% (n=3) heard no difference. The center formation had a mean score of 2.1 and a standard deviation of 1.2. The blocked-section formation indicated a mean preference degree rating of 2.6 with a standard deviation of .755 (See Table 5). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the center excerpt, the blocked-section excerpt and the indication of no difference χ^2 (2, N= 120) = 137.45, p < .05. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. This comparison revealed that the blocked-section formation excerpt was preferred significantly more than the center formation excerpt χ^2 (1, N= 110) = 57.48, p < .05.

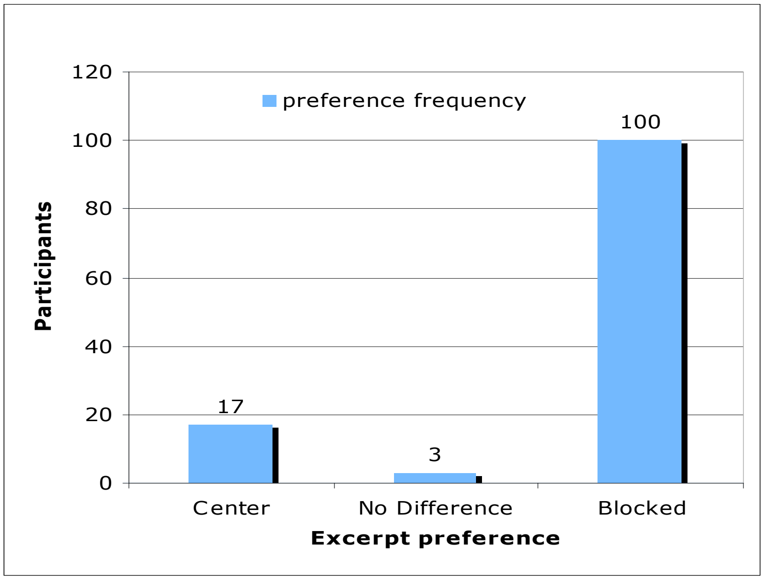

Figure 9. *Center vs. Blocked-section preference responses for all participants*

Random vs. Center formation. In pair five, the random formation was compared with the center seating formation. Figure 10 shows that overall 80% (n=96) preferred the random formation; 14% (n= 17) preferred the center formation; and 6% (n=7) indicated they heard no difference. The random formation had a mean preference degree of 2.8 and a standard deviation of 1.23.The center formation showed a mean preference degree of 2.3 with a standard deviation of 1.3 (See Table 5). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the random excerpt, the center excerpt and the indication of no difference χ^2 (2, N= 120) = 118.85, p < .05. To determine if the significant difference was between the two conditions, a follow-up Chi-square was computed. Chi-square comparison revealed that the random formation excerpt was preferred significantly more than the center formation excerpt χ^2 (1, N= 113) = 53.84, p < .05.

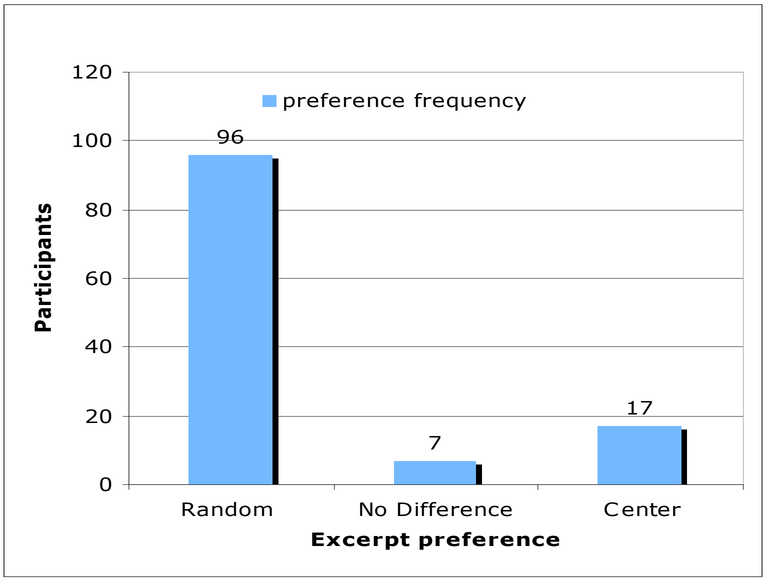

Figure 10. *Random vs. Center preference responses for all participants*

Families vs. Blocked-section formations. In pair six, the families formation was compared with the blocked-section seating formation. Figure 11 shows that overall 38% (n= 45) preferred the families formations; 34% (n= 41); and 28% (n= 34) heard no difference. The families formation had a mean of 2.2 and a standard deviation 1.2. The blocked-section formation had a mean of 2.3 and a standard deviation of 1.1 (See Table 5). A Chi-square of the three response choices (A, B, "no difference") revealed no significant difference between the families excerpt, the blocked-section excerpt and the indication of no difference χ^2 (2, N= 120) = 1.55, p > .05. It is important to note that pair six was the only pair not to show significance in overall response comparisons. The frequency of preferences indicated for either excerpt or "no difference" indications were closer than for any other comparison of matched pairs.

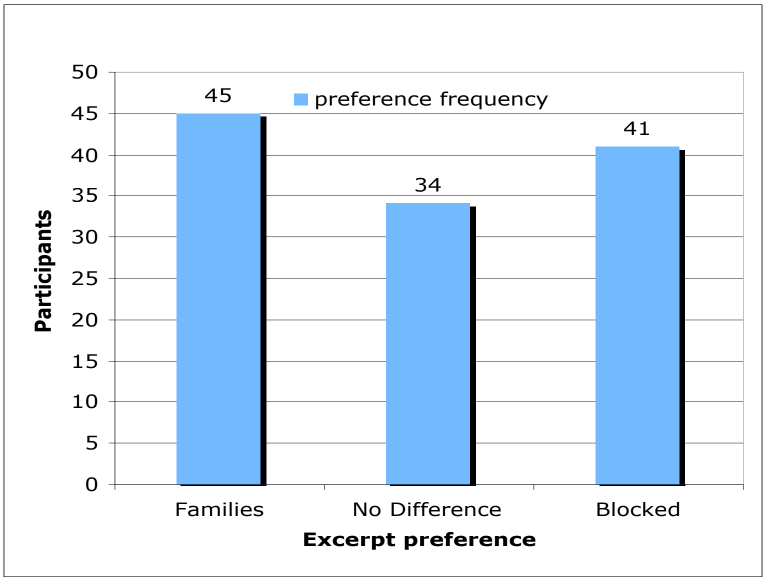

Figure 11. *Families vs. Blocked-section preference responses for all participants*

Summary. Data of the overall frequency responses were put in rank-order and showed that the center formation was preferred significantly less than the random, families and blocked formations. Results showed that the center formation was preferred significantly less than the other three formations. Results also showed that with exception to the center formation, there was no significant difference between any of the other formations (random, families and center). These results indicate that overall, with the exception of the center formation, listeners had no preference for the specific wind ensemble formations used in this study. A follow-up examination was done to determine whether listeners had a preference for specific formations when compared excerpt-to-excerpt. Results revealed significant overall differences among the three possible responses (A, B, "no difference") for all formation pairs, with the exception of pair six that compared families versus blocked-section formations. Most of these significant differences existed between preference responses for one of the excerpts and the "no difference" response. A follow up Chi-square was carried out using only preference responses for either excerpts A or B. Results of these analyses revealed a significant difference between the following formation excerpts: families vs. center, center vs.

blocked, and random vs. center. The areas of significance within excerpt-to-excerpt pairs further supports the earlier conclusion that the center formation was preferred significantly less than the other three formations. Results also support the earlier conclusion that with the exception of the center formation, listeners have no preference for the specific wind ensemble formations used in this study.

Research Question Three

Which musical factors most influenced listeners' preference for four virtual band formations (blocked sections, families, random, or center)?

When participants expressed a preference for one excerpt over another, they were then asked to indicate which musical factor they felt most contributed to their preference. The response format was forced choice among the following five musical factors: balance/blend, pitch/intonation, tone quality, tempo, and volume.

Overall listening perceptions. There were 720 auditors' responses indicating musical factors that contributed to their preference choices. Percentage data revealed the following breakdown of given responses: 3% (17) tempo, 11% (69) volume, 54% (351) balance/blend, 9% (62) pitch/intonation, and 23% (153) tone quality (See Table 6). A preliminary Chi-square analysis was computed to determine differences among the five possible responses, with no regard to listening condition. These analyses revealed a significant difference between response categories χ^2 (4, N= 652) = 540.52, $p < .05$. A follow up Chi-square was carried out and indicated that balance and blend was chosen significantly more often than the next highest response category of tone quality χ^2 (1, N= 504) = 77, $p < .05$.

Musical factor responses were also examined within each pair of formation excerpts. In all excerpt pairs, balance and blend was the musical factor selected most often by auditors as the factor contributing to their preference responses. Chi-square analyses indicated that balance and blend was chosen significantly more often than the next highest response category of tone quality for all pairs, with the exception of pair four that compared center versus blocked-section formations. (See Table 7). Overall, results indicate that balance/blend was the musical factor given by participants that most influenced preference response.

Research Question Four

Do preferences for overall wind ensemble sound differ when stimulus excerpts are heard via headphones or in a free-field listening environment?

Prior to data collection, participants were randomly assigned to one of two listening conditions: headphones or free-field listening. These listening conditions were employed to determine if a difference in preference responses occurred when participants listened to the excerpts binaurally or free-field. Binaural environments are those in which sounds, sent to the right and left channel, are heard only by the respective ear, as opposed to a free field environment in which there is a crossover of sounds from the left and right channels to both ears. Frequency response for the four formations was collected for each listening condition. From these data, final preference rank orders of the four formations were determined and are reported by listening condition in Table 8. Chi-square analyses of this overall preference rank shows significant differences between the blocked-section and center formations for the headphone group χ^2 (1, N= 104) = 29.08, $p < .05$ and the speaker group χ^2 (1, N= 128) = 48.76, $p < .05$. All other analyses of overall frequency responses yielded no significant differences for both listening conditions.

Further examination was done for each of the six formation pairs to examine preference differences between listening conditions when ensemble formations were compared in an excerpt to excerpt format. For each of the six pairs, a Chi-square analysis was carried out to determine overall differences among the three possible responses (A, B, “no difference”), for both headphone and speaker groups. A follow up Chi-square was then carried out using only preference responses for A or B excerpts. Results of these analyses are reported in the following sections.

Table 6.

Overall response totals for listener perception of contributing musical factors.

Blocked-section vs. random		Tempo	Volume	Bal/Blend	Pitch/Inton.	Tone Qual.
Headphones	Ex. A		2	9	1	
	Ex. B			31	2	8
Speakers	Ex. A			23	1	8
	Ex. B	1		19		5
	Total A	0	2	32	2	8
	Total B	1	0	50	2	13
random vs. families						
Headphones	Ex. A	3	1	12	5	7
	Ex. B	2	1	10	4	8
Speakers	Ex. A		2	22	1	6
	Ex. B		1	16	3	6
	Total A	3	3	34	6	13
	Total B	2	2	26	7	14
families vs. center						
Headphones	Ex. A	2	6	24	5	16
	Ex. B		1	3		2
Speakers	Ex. A		12	26	1	10
	Ex. B		2	4	1	1
	Total A	2	18	50	6	26
	Total B	0	3	7	1	3
center vs. blocked						
Headphones	Ex. A		1	3	2	2
	Ex. B	1	4	20	10	16
Speakers	Ex. A			6	1	2
	Ex. B		11	23	2	13
	Total A	0	1	9	3	4
	Total B	1	15	43	12	29
random vs center						
Headphones	Ex. A		2	21	9	15
	Ex. B	1	3	5		1
Speakers	Ex. A		10	26	4	9
	Ex. B	1	1	1	2	2
	Total A	0	12	47	13	24
	Total B	2	4	6	2	3
families vs. blocked						
Headphones	Ex. A	3	1	5	3	4
	Ex. B		5	10		3
Speakers	Ex. A		2	20	4	4
	Ex. B	3	1	12	1	5
	Total A	3	3	25	7	8
	Total B	3	6	22	1	8
Overall totals		17	69	351	62	153

Table 7.
Chi-square comparisons for musical factor responses in tone quality and balance/blend categories of matched pairs.

Excerpt pairs	Tone quality	Balance/Blend	χ^2	*p*
Blocked vs. Random	21	82	34.96	.01*
Random vs. Families	27	60	11.78	.006*
Families vs. Center	29	57	8.48	.03*
Center vs. Blocked	33	52	3.82	.05*
Random vs. Center	27	53	7.82	.05*
Families vs. Blocked	16	47	14.28	.002*

* Significant at alpha level of .05

Blocked-section vs. Random formation. Responses for both listening groups were graphed for visual comparison (See Figure 12). The headphone group shows that overall 16 % (n= 10) of auditors preferred the blocked-section excerpt, 71% (n = 43) preferred the random excerpt and 11% (n= 7) heard no difference. The blocked section formation had a mean score of 2.7 and a standard deviation of 1.16. The random formation indicated a mean preference rating of 3.0 with a standard deviation of 1.0 (See Table 9). A Chi-square analysis comparing the three response choices (A, B, "no difference") revealed a significant difference between the blocked section excerpt, the random excerpt B and the indication of "no difference" χ^2 (2, N= 60) = 39.9, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for blocked section and random formations within the headphones listening condition χ^2 (1, N= 53) = 19.32, $p < .05$.

The speakers group shows that overall 55 % (n= 33) of auditors preferred the blocked-section excerpt, 41% (n = 25) preferred the random excerpt and 3% (n= 2) heard no difference (See Figure 12). The blocked section formation had a mean score of 2.6 and a standard deviation of .93. The random formation indicated a mean preference rating of 2.2 with a standard deviation of 1.15 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the blocked section excerpt, the random excerpt B and the indication of "no difference" χ^2 (2,

N= 60) = 25.9, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up Chi-square was computed. These analyses indicated no significant difference between responses for the blocked section or random formations within the speakers listening condition χ^2 (1, N= 58) = .84, $p > .05$, thus indicating that significant differences existed between the "no difference" response and preference responses for either excerpt A or B. Results of Chi-square analysis for both listening conditions showed that the random formation was preferred significantly more than the blocked-section formation in the headphones group, but not in the speakers group.

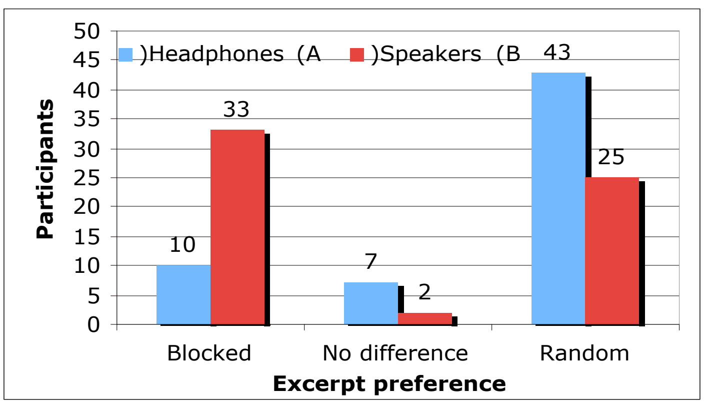

Figure 12. *Blocked-section vs. Random preference responses for headphone and speaker listening groups.*

Table 8

Rank-order of overall preference responses for all virtual seating formations in headphone and speakers listening conditions.

Listening Group	Formation	Frequency
Headphones	Random	118
	Families	92
	Blocked	80
	Center	24
Speakers	Random	105
	Families	105
	Blocked	104
	Center	24

Table 9.

Mean and Standard deviations for degree of preference ratings of matched formation pairs in both listening groups.

Pairs		Mean		Standard Deviation	
		Headphones	Speakers	Headphones	Speakers
1	Blocked-section	2.7	2.6	1.15	.93
	Random	3.0	2.2	1.01	1.1
2	Random	2.3	2.5	1.15	1.2
	Families	2.6	2.2	1.11	.9
3	Families	3.1	3.1	1.1	1.2
	Center	2.5	2.6	.84	.7
4	Center	1.6	2.4	1.1	1.2
	Blocked-section	3.0	2.9	1.2	1.2
5	Random	2.9	2.8	1.3	1.1
	Center	1.9	2.9	1.4	1.8
6	Families	1.7	2.4	.96	1.3
	Blocked-section	2	2.5	1.2	.9

Random vs. Families formation. Responses for both listening groups were graphed for visual comparison (See Figure 13). The headphone group data show that overall 46 % (n= 28) of auditors preferred the random excerpt, 41% (n = 25) preferred the families excerpt and 11% (n= 7) heard no difference. The random formation had a mean score of 2.3 and a standard deviation of 1.15. The families formation indicated a mean preference rating of 2.6 with a standard deviation of 1.1 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the random excerpt, the families excerpt and the indication of "no difference" χ^2 (2, N= 60) = 12.9, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up Chi-square was computed. These analyses indicated no significant difference between responses for random and families formation within the headphones listening condition χ^2 (1, N= 53) = .08, p =.77.

The speakers group shows that overall 52 % (n= 33) of auditors preferred the random excerpt, 43% (n = 26) preferred the families excerpt and 5% (n= 3) heard no difference (See Figure 13). The random formation had a mean score of 2.5 and a standard deviation of 1.2. The families formation indicated a mean preference rating of 2.2 with a standard deviation of .94 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the random excerpt, the families excerpt and the indication of "no difference" χ^2 (2, N= 60) = 22.3, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated no significant difference between responses for the random and families formations within the speakers listening condition χ^2 (1, N= 57) = .28, p = .596, therefore indicating that significant differences existed between the "no difference" response and preference responses for either excerpt A or B. Results of Chi-square analysis showed no significant difference between the random formation and the blocked-section formation in the headphones group or the speakers group. Overall response totals for listener perception of contributing musical factors were examined earlier and show a significant preference for balance and blend (See Table 7). Therefore this aspect will not be examined with regards to listening condition.

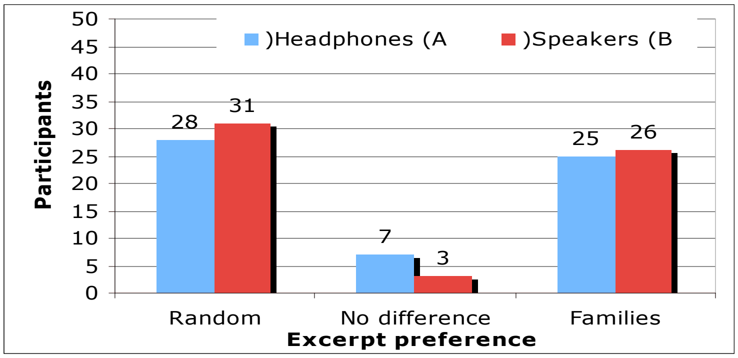

Figure 13. *Random vs. Families preference responses for headphone and speaker listening groups.*

Families vs. Center formation. Responses for both listening groups were graphed for visual comparison (See Figure 14). The headphone group shows that overall 87 % (n= 52) of auditors preferred the families excerpt, 10% (n = 6) preferred the center excerpt and 3% (n= 2) heard no difference. The families formation had a mean score of 3.1 and a standard deviation of 1.1. The center formation indicated a mean preference rating of 2.5 with a standard deviation of .84 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the families excerpt, the center excerpt and the indication of "no difference" χ^2 (2, N= 60) = 77.2, p < .05. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for the families and center formations within the headphones listening condition χ^2 (1, N= 58) = 34.92, p < .05.

The speakers group shows that overall 82% (n= 49) of auditors preferred the families excerpt, 13% (n = 8) preferred the center excerpt and 5% (n= 3) heard no difference (See Figure 14). The families formation had a mean score of 3.1 and a standard deviation of 1.17. The center formation indicated a mean preference rating of 2.6 with a standard deviation of .74 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the families excerpt, the center excerpt and the indication of "no difference" χ^2 (2, N= 60) = 63.7, p < .05. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for the families and center formations within the speakers listening condition χ^2 (1, N= 57) = 28.08, p < .05. An overview of results showed that the families formation was preferred significantly more than the center formation in the headphones group and the speakers group. Overall response totals for listener perception of contributing musical factors were examined earlier and show a significant preference for balance and blend (See Table 7). Therefore this aspect will not be examined with regards to listening condition.

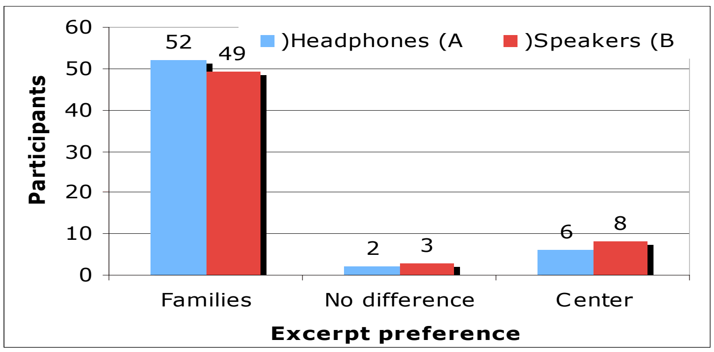

Figure 14. *Families vs. Center preference responses for headphone and speaker listening groups.*

Center vs. Blocked-section formation. Responses for both listening groups were graphed for visual comparison (See Figure 15). The headphone group shows that overall 13 % (n= 8) of auditors preferred the center excerpt, 2% (n = 1) preferred the blocked-section excerpt and 85% (n= 51) heard no difference. The center formation had a mean score of 1.6 and a standard deviation of 1.1. The blocked-section formation indicated a mean preference rating of 3.0 with a standard deviation of 1.15 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the center excerpt, the blocked-section excerpt and the indication of "no difference" χ^2 (2, N= 60) = 73.3, p < .05. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for the center and blocked-section formations within the headphones listening condition χ^2 (1, N= 59) = 29.9, p < .05.

The speakers group shows that overall 82% (n= 49) of auditors preferred the center excerpt, 15% (n = 9) preferred the blocked-section excerpt and 3% (n= 2) heard no difference (See Figure 15). The center formation had a mean score of 2.4 and a standard deviation of 1.23. The blocked-section formation indicated a mean preference rating of 2.9 with a standard deviation of 1.15 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the center excerpt, the blocked-section excerpt and the indication of "no difference" χ^2 (2, *N*= 60) = 64.3, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for the center and blocked-section formations within the speakers listening condition χ^2 (1, *N*= 58) = 26.22, $p < .05$. An overview of results showed that the blocked-section formation was preferred significantly more than the center formation in the headphones group and the speakers group.

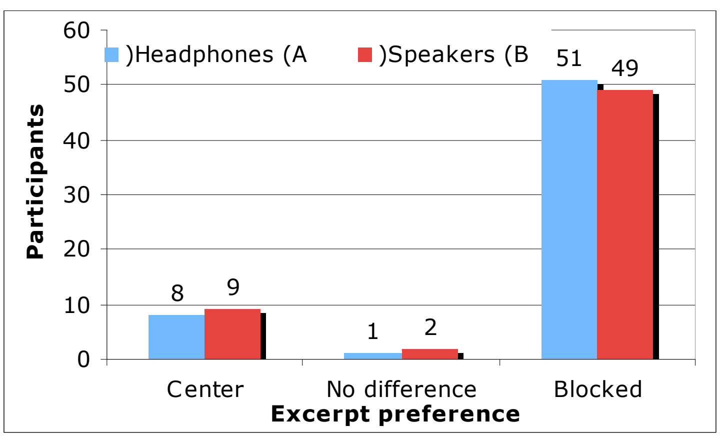

Figure 15. *Center vs. Blocked-section preference responses for headphone and speaker listening groups.*

Random vs. Center formation. In the fifth matched pair responses for both listening groups were graphed for visual comparison (See Figure 16). The headphone group shows that overall 78 % (n= 47) of auditors preferred the random excerpt, 17% (n = 10) preferred the center excerpt and 5% (n= 3) heard no difference. The random formation had a mean score of 2.9 and a standard deviation of 1.3. The center formation indicated a mean preference rating of 1.9 with a standard deviation of 1.2 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the random excerpt, the center excerpt and the indication of "no difference" χ^2 (2, N= 60) = 55.9, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for the random and center formations within the headphones listening condition χ^2 (1, N= 57) = 22.74, $p < .05$.

The speakers group shows that overall 82% (n= 49) of auditors preferred the random excerpt, 12% (n = 7) preferred the center excerpt and 6% (n= 4) heard no difference (See Figure 16). The random formation had a mean score of 2.8 and a standard deviation of 1.14. The center formation indicated a mean preference rating of 2.8 with a standard deviation of 1.34 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the families excerpt, the center excerpt and the indication of "no difference" χ^2 (2, N= 60) = 63.3, $p < .05$. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated a significant difference between responses for the families and center formations within the speakers listening condition χ^2 (1, N= 56) = 30.02, $p < .05$. An overview of results indicated that the random formation was preferred significantly more than the center formation in the headphones group and the speakers group. Overall response totals for listener perception of contributing musical factors were examined earlier and show a significant preference for balance and blend (See Table 7). Therefore this aspect will not be examined with regards to listening conditions.

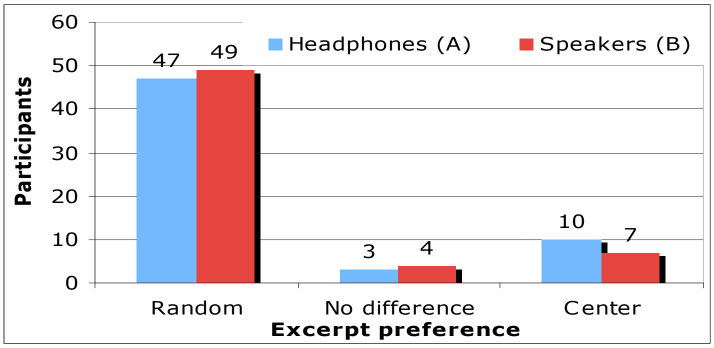

Figure 16. *Random vs. Center preference responses for headphone and speaker listening groups.*

Families vs. Blocked-section formation. Responses for both listening groups were graphed for visual comparison (See Figure 17). The headphone group shows that overall 28 % (n= 15) of auditors preferred the families excerpt, 32% (n = 19) preferred the blocked-section excerpt and 43% (n= 26) heard no difference. The families formation had a mean score of 1.7 and a standard deviation of .96. The blocked-section formation indicated a mean preference rating of 2 with a standard deviation of 1.2 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed no significant difference between the families excerpt, the blocked-section excerpt and the indication of "no difference" χ^2 (2, N= 60) = 3.1, p =.21, thus negating the need for a statistical follow-up between both preference response categories.

The speakers group shows that overall 50% (n= 30) of auditors preferred the families excerpt, 37% (n = 7) preferred the blocked-section excerpt and 13% (n= 8) heard no difference (See Figure 17). The families formation had a mean score of 2.4 and a standard deviation of 1.25. The blocked-section formation indicated a mean preference rating of 2.5 with a standard deviation of .96 (See Table 9). A Chi-square analysis of the three response choices (A, B, "no difference") revealed a significant difference between the families excerpt, the blocked-section excerpt and the indication of "no difference" χ^2 (2, N= 60) = 12.4, p < .05. To determine if the significant difference was between the two excerpts, a follow-up analysis was computed. These analyses indicated no significant difference between responses for the families and blocked-section formations within the speakers listening condition χ^2 (1, N= 52) = .94, p =.33, therefore indicating that significant differences existed between the "no difference" response and preference responses for either excerpt A or B. Results An overview of results showed no significant difference between the random formation and the blocked-section formation in the headphones group or the speakers group. Overall response totals for listener perception of contributing musical factors were examined earlier and show a significant preference for balance and blend (See Table 7). Therefore this aspect will not be examined with regards to listening conditions.

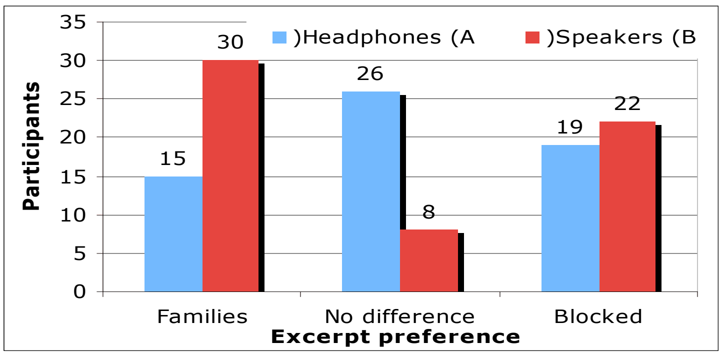

Figure 17. *Families vs. Blocked-section preference responses for headphone and speaker listening groups.*

Summary. Rank-order data reveal that for both headphone and free-field listening conditions the only area of significance lies in the comparison of the two formations preferred the least (blocked and center). All other comparisons related to overall preference response are not significant for either listening condition, therefore indicating that preferences for overall wind ensemble sound do not differ when stimulus excerpts are heard via headphones or in a free-field listening environment.

Secondary analyses were done to determine whether listener's had a preference for specific formations when compared excerpt-to-excerpt in headphones versus speakers groups. Results revealed significant overall differences among the three possible responses (A, B, "no difference") for all formation pairs, with the exception of pair six that compared families versus blocked-section formations. Most of these significant differences existed between preference responses for one of the excerpts and the "no difference" response. A follow up Chi-square was carried out using only preference responses for either excerpts A or B. Results of these analyses revealed one difference between preferences for overall wind ensemble formations when stimulus excerpts were heard via headphones or in a free-field listening environment This difference occurred in the headphone group of the blocked-section and random formation comparison.

CHAPTER 5
DISCUSSION

The primary purpose of this study was to examine the effect of various wind ensemble formations (blocked sections, families, random and center) on auditors' perceptions of, and preferences for overall wind ensemble sound. A secondary purpose of the study was to examine participants' responses under two listening conditions: headphones and speakers. This chapter includes discussion on each research question, the study's relationship to past research, limitations of the study, implications for practice, conclusions, and areas for future study.

Research Question One

The first question of this study dealt with listeners' ability to perceive a difference among recordings in which wind ensemble sections change position. Yarbrough (1987) pointed out that in order for someone to indicate a preference they must first be able to make discriminations about what they hear. This question was essential in being able to examine any other aspects of this study. Results of the overall data analyses revealed that listeners could in fact hear a difference between the four different recordings that were used as stimuli. When these same perception data were examined within the six pairings, all pairs mirrored the results of the overall analysis with the exception of pair six. The sixth pair, which compared the families and blocked-section formations, showed no significant difference between the three response categories. These data do not necessarily indicate that no one heard a difference between the two excerpts, but that listeners may have perceived the families and blocked-section formations to be similar in overall ensemble sound.

Results of the present corroborate earlier research which found that listeners can make differentiations in musical sounds (Geringer & Madsen, 1998). Results of these discrimination studies also indicate that musicians, in most cases, are better able than nonmusicians to discriminate musical differences such as altered melodies (Madsen & Madsen, 2002), performance quality (Geringer & Madsen, 1998), pitch (Duke, Geringer, & Madsen, 1988), and tone quality (Geringer & Worthy, 1999). Participants in the present study were all music majors, which may account for the high percentage of participants who heard a difference between seating formations.

<u>Research Question Two</u>

The second research question was posed to determine auditors' preferences for specific wind ensemble formations. The four virtual formations used in this study (blocked sections, families, random, or center) were chosen in an effort to replicate, as much as possible, formations that are typically used by wind ensembles in live performance settings. Results of the analyses revealed that three of the formations (random, families and blocked-section) were preferred significantly more than the fourth formation (center); thus, indicating that the center formation was clearly the least preferred formation. The rank-order based on preference showed that the random formation was ranked highest, followed by the families and blocked-section formation. However, Chi-square analyses revealed no significant difference between preference responses for these three formations; thus, indicating no clear preference for one specific wind ensemble formation. Daugherty (1999) also found that formation was not a contributing factor for differences heard in the overall sound of an ensemble. Daugherty found that spacing among performers was the factor that contributed most to preferences for overall sound.

Although not specifically examined in this study, spacing may have been a factor in preferences for one of the formations. The random formation received more preference responses than the other three formations. The term "random" indicated that instrument sections were randomly placed at one of the five pan positions, resulting in two sections at all positions. These placements resulted in an even distribution of instrument sections. These data may lend support to Daugherty (1996; 1999) who found that spacing, not formation, had a significant effect on preference for overall sound.

The blocked-section formation used in this study was designed to replicate the ensemble seating formation typically used by the wind ensemble that recorded the excerpts. This seating is used for all pieces, in all rehearsals and concerts, and in all halls. While a blocked seating formation is similar to formations also used by most other bands and wind ensembles (Begian, 1997; Garafolo & Whaley, 1976; Miles, 2004), this formation ranked lower than the random or families formation for overall preference responses and degree of preference.

In the families formation, all woodwind instruments were placed together and all brass instruments were placed together. This type of formation was based on recommendations made by Gifford (1995) and Page (2004) who advocated keeping instrument families together to produce a better blend of sound. Participant responses in the present study, however, did not indicate a clear preference for the families formation.

Most authors who have written about wind ensemble formation agree there is no single formation that is best suited to every ensemble (Hunsberger, 1985; Kruth, 1996; Renshaw, 2000). These authors' opinions, along with the preference of participants in the present study, support the conclusion that there is acceptance for a wide variety of wind ensemble formations.

Research Question Three

This question was posed to determine which musical factor(s) most influenced listeners' preferences for seating formations (blocked sections, families, random, or center). The response format was forced-choice among the following five musical factors: balance/blend, pitch/intonation, tone quality, tempo, and volume. Overall results showed that balance/blend was cited as the musical factor that most contributed to preference responses. This finding is not surprising, as balance and blend was the only musical factor not controlled for in the recording of the excerpts. Although balance and blend was selected more than the other given musical factors, it is important to remember that these results indicate only why one excerpt was chosen over another, and does not imply that one formation resulted in better balance and blend. Overall preference responses revealed that listeners most often chose balance and blend, regardless of which excerpt they preferred. These results suggest that listeners' definition of good balance and blend differ. This same observation could be made for indications of tone quality and pitch/intonation. It is also possible that other factors not listed could have contributed to these results.

By using identical recordings for each pair, factors such as tempo, tone quality, pitch/intonation, and volume were controlled. Nevertheless, participants still indicated that these musical factors affected their preferences. Of these controlled factors, tone quality received the most responses. In examining the data, it seems that differences in tone quality might have been perceived when listening to formations that had three or more instrument sections at one pan setting. Such is the case for the families, blocked-section and center formations. Page (2004) stated that when instruments of similar voicings sit together, the distinct tone colors of the instruments are lost. This opinion may help to explain the numerous responses for tone quality.

Amplitude was not purposely altered in the recording or in the mixing; however, when the center formation had all instrument sections placed at the zero pan setting, instrument section tracks were heard equally out of both the left and right channels. This setting resulted in an inadvertent increase in loudness. Loudness, as a reason for preference, was selected in all formation pairings, but the majority of responses were found in the pairs that included the center formation. This inadvertent increase in amplitude may account for the number of volume responses given for pairs that included the center formation. The increase in volume may also have implications for responses of balance and blend.

Responses indicating tempo as the factor contributing to preference are the most curious. All recordings were at the same tempo. The playback of excerpts A and B were synchronized within milliseconds of one another. Perception of tempo differences could be related to the use of the audio switchbox. As auditors switched back and forth between excerpts, the switchbox interrupted the sound for a millisecond before the audio from the other excerpt was heard. This monetary loss of continuous sound may have been enough for certain listeners to perceive that the two excerpts were not together, and that one excerpt might be faster than the other excerpt. Reasons for preference may also have been random.

Overall, results of question three indicate that balance/blend is considered a key factor in producing a characteristically "good" wind ensemble sound (Gale, 2001; Garafolo, 1996; McBeth, 1972). Results of the present study also support suggestions that preferred wind ensemble formations are those that address proper balance and blend (Colwell & Goolsby, 1991; Kruth, 1996; Page, 2004).

Research Question Four

The fourth and final question was posed to determine whether preferences for overall wind ensemble formation differ when stimulus excerpts are heard via headphones or in a free-field listening environment. Results indicated that preferences for wind ensemble formations were not related to listening conditions. The overall rank-order of preference responses for all virtual seating formations was the same for both listening conditions.

One difference in responses between headphones and speakers groups was found in pair one. In this pair, the headphones group preferred the random formation significantly more than the blocked-section formation. Although significant, these listening preferences may have been affected by presentation order. Participants were not given a practice excerpt, by which they could acclimate themselves to the listening task. This omission might have inadvertently affected preference responses in the first pair of excerpts.

Results of listening condition data support the findings of Geringer and Dunnigan (2000) who found no difference in headphone and speaker listening conditions when indicating preferences for analog and digital recordings. Possible differences due to listening conditions were assessed due to the technique used to prepare the music stimuli. Because the musical stimulus was being produced using digital pan settings, it was thought that the binaural nature of headphones would produce a clearer depiction of the direction of the sound source. Free-field listening was examined because that is the environment in which most concert listening takes place. Similarly, the sound signals sent to the left and right speaker channels are heard by both ears.

<u>Limitations of this Study</u>

One possible factor affecting this study was the need to use recordings of virtual seating formations produced digitally, instead of using recordings made from a live ensemble sitting in four different seating formations. Although the use of a virtual environment controlled for performer differences as a confounding variable, stimuli used in the present study are based on approximations of how one thinks a wind ensemble would sound if placed in various formations. The four virtual formations do not account for, at the least:

1) the acoustics of the performance hall,

2) directionality of certain instruments,
3) the natural masking of sounds that typically occur due to physical bodies on stage, and
4) the conscious or unconscious adjustments made by performers during the course of a live performance.
5) No percussion voices

An additional limitation of this study was closed response format used to determine preference responses. A free response format may have provided greater insight into reasons for listeners' preferences for and perceptions of sound. The addition of option to respond with "other" may have been useful. The closed response format may have also forced listeners into over generalizing or mislabeling their perceptions of the ensemble sound. It is also important to note that listening preferences and perceptions could have been altered due to recording artifacts caused by the microphones or recording devices that were used in this study.

Conclusions

The results of this study offer several conclusions related to preferences for, and perceptions of wind ensemble formations. The results of this study provide empirical data to support the numerous opinions that indicate seating formations may not be the essential feature in producing a characteristic wind ensemble sound. This conclusion supports Daugherty's (1999) findings in regard to choral formations. The necessity of the present study was to determine whether similar results would occur with an ensemble comprised of non-homogeneous timbres.

Conductors have discussed the need to place principal players together to improve intonation (Bourgeois, 1988; Garafolo, 1996). Conductors have also cited a need to put instruments of similar voicings together so that performers can more easily hear who has a similar musical line (Cooper, 2004). Perhaps, the benefit of sitting in various formations lies not with the listener, but instead with the performers and conductor. The formations chosen by conductors are designed to give performers the greatest opportunity to produce a sound that is balanced, in-tune, articulated and contrasted both dynamically and temporally. If this type of sound can be produced in various seating formations, then advocating for a specific formation has little meaning. As stated in the introduction of this dissertation, it may be that form, particularly in regard to ensembles, is a product of function.

Formations in our environment are derived logically from the need to have various elements of the environment function in certain ways. This study served to examine types of formations and their function in influencing listeners' preferences and perceptions of overall ensemble sound. Results of the present study indicate that the function of formation was the discriminations of a sound difference, though not a recognizable sound preference. The study also provides a basis from which to further study the influences of fixed and semi-fixed features in a sound environment. It was initially stated that nothing exists in a vacuum. This study helped to form a clearer picture of the wind band environment by examining one sphere of influence, and its effect on other musical aspects of the performing ensemble.

Suggestions for Further Research

Further study of formations using an intact wind ensemble would provide greater latitude in formations used, and ultimately a real-world examination of differences in seating formations. The current study seemed to be necessary precursor to any research done with a full ensemble. Virtual formations were used in the present study to control for differences due to performance variations. The results of this study provide a baseline, of sorts, by which to compare the findings of a study employing a live intact ensemble.

Future researchers may also wish to examine the variable of spacing related to ensemble sound. An examination of one ensemble formation recorded with several different spacings may add support to past empirical research which found spacing to be more consequential than formation to overall ensemble sound (Daugherty, 1996, 1999).

Several other areas of investigation related to musical factors and sound recordings also seem warranted. Results from the current study revealed that balance and blend was the musical factor that listeners' indicated as affecting their preferences for seating formations. Future research may allow participants to adjust volume levels in a multi-track recording to better determine what they consider to be a characteristic wind ensemble sound. Such a study may assist researchers in gaining a more precise understanding of listeners' balance and blend preferences for a wind ensemble sound.

Another important aspect related to sounds preferences concerns the difference between listening to a live performance and a recorded performance. As discussed in the review of literature, most recording methods for music can only simulate sound placement from left to right. Unlike live performances, stereo recordings do not replicate depth from front to back. With the burgeoning technology in head-related transfer functions (HRTF), recordings can now begin to more accurately replicate three-dimensional sound environments. Further research related to seating formation preferences would benefit greatly from the use of such technology. A wind ensemble, set in different formations, and recorded using HRTF techniques, would result in a sound that more closely approximates a live environment.

Empirical research related to formation in all ensemble types has been minimal. Most of the literature related to the study of formation and its effect on overall sound consists of unsubstantiated opinion pieces. Considering that seating formation is a physical reality for ensembles of any size or type, further research to better understand its effect on overall ensemble sound seems warranted, as well as to investigate its importance to performer and listener preferences, and performers' communication with each other. Future research related to ensemble seating formations may help to assist musicians in their ultimate goal of producing the best possible sound, and in providing clearer channels of communication with the conductor.

APPENDIX A:
Human Subjects Committee Approval

Florida State
UNIVERSITY

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 4/28/2006

To:
Sean Murray
1203 Firethorn Ln.
Tallahassee, FL 32303

Dept. **COLLEGE OF MUSIC**

From: **Thomas L. Jacobson, Chair**

Re: **Use of Human Subjects in Research**
The effect of wind ensemble seating formations on perception and preferences of auditors

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and two members of the Human Subjects Committee. Your project is determined to be Exempt per 45 CFR § 46.101(b) 2 and has been approved by an accelerated review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If the project has not been completed by **4/25/2007** you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

Cc: Alice-Ann Darrow
HSC No. 2006.0314

APPENDIX B:
Informed Consent Form

Informed Consent Form

Dear Participant:

I am a doctoral graduate student under the direction of Professor Alice-Ann Darrow in the College of Music at Florida State University. I am conducting a research study to examine the effect of acoustical panels on overall ensemble sound.

I am requesting your participation, which will involve listening to six musical excerpts and the being asked to answer three short questions dealing with your preferences and perceptions. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. The results of the research study may be published, but your name will not be used.

There are no foreseeable risks or discomforts if you agree to participate in this study. Although there may be no direct benefit to you, the possible benefit of your participation is a greater understanding of research focus in music education.

If you have any questions concerning the research study, please ask prior to the start of the listening portion of the study.

Any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by:
Sean Murray, researcher
1203 Firethorn Ln. Tallahassee, Fl 32303
(850) 562-4804
murraysean@mac.com

Dr. Alice-Ann Darrow, supervising professor
College of Music
Florida State University
Tallahassee, FL 32306-1180
(850) 645-1438
aadarrow@fsu.edu

If I have questions about my rights as a subject/participant in this research, or if I feel I have been placed at risk, I can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Office of the Vice President for Research, at (850) 644-8633.

Return of the questionnaire will be considered your consent to participate. Thank you.

Sincerely,

Sean Murray

APPENDIX C:
Auditor Evaluation Form

Auditor Evaluation form _____ A B

Part 1:

1. **Your present age?_________**

2. **Your gender?**

    a) Female b)Male

3. Do you have a degree in music? If yes, indicate the level of your last degree

    a) No
    b) Bachelor's
    c) Master's
    d) Doctorate

4. Do you have a degree in wind conducting or band music education? If yes, indicate the level of you last degree?

    a) No
    b) Bachelor's
    c) Master's
    d) Doctorate

5. Are you currently working on a degree in either wind conducting or band music education?

    a) No
    b) Yes

6. Have you ever been a member of any choir, band, or orchestra at any time from your first year in high school to the present day?

    a) No
    b) Yes

7. Have you played in a band for two or more years at any time from your first year in high school to the present day?

    a) No
    b) Yes

8. Have you ever taken private lessons on the same musical instrument for a year or more?

    a) No

b) Yes

9. Have you ever been told you had a hearing loss?

a) No

b) Yes

10. How would you evaluate you hearing?

a) Normal

b) Better than normal

c) Slight hearing loss

d) Moderate hearing loss

e) Severe hearing loss

When the proctor gives you instructions to do so, please put on your headphones and go on to the next page of this booklet.

Part 2: Please follow along as these directions are read to you on the CD:

In a moment, you will hear two performances of the same musical excerpt played at the same time. During the listening task you will be able to switch back and forth between both excerpts in order to easily make comparisons. Each excerpt is 60 seconds in duration. Please listen and from your own opinion on the overall ensemble sound of each excerpt. After the excerpt is finished please respond to the following questions:

1) Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

For each set of paired excerpts mark the response form from -5 to +5 to indicate your level of preference for either excerpt A or B. Zero indicates no difference between excerpt A and B.

i. **IF you heard a difference between the overall sounds of these two performances please indicate which one, if any, of these factors below MOST influenced your perception?**

Only answer the third question if you heard a difference in overall ensemble sound. Please make sure to circle your answer on the response form.

Continue onto the next page

Part 3: Please answer the following questions for each pair of recorded excerpts:

Pair #1

1. Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

	5	4	3	2	1	0	1	2	3	4	5	
Excerpt A						no difference						Excerpt B

2. <u>IF</u> you heard a difference between the overall sound of these two performances please indicate which one, if any, of these factors below MOST influenced your perception:

    a. Tempo
    b. Volume
    c. Balance / Blend
    d. Pitch/ Intonation
    e. Tone Quality

Pair #2

1. Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

	5	4	3	2	1	0	1	2	3	4	5	
Excerpt A						no difference						Excerpt B

2. <u>IF</u> you heard a difference between the overall sound of these two performances please indicate which one, if any, of these factors below MOST influenced your perception:

   a. Tempo
   b. Volume
   c. Balance / Blend
   d. Pitch/ Intonation
   e. Tone Quality

Pair #3

1. Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

	5	4	3	2	1	0	1	2	3	4	5	
Excerpt A						no difference						Excerpt B

2. <u>IF</u> you heard a difference between the overall sound of these two performances please indicate which one, if any, of these factors below MOST influenced your perception:

   a. Tempo
   b. Volume
   c. Balance / Blend
   d. Pitch/ Intonation
   e. Tone Quality

Pair #4

1. Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

	5	4	3	2	1	0	1	2	3	4	5	
Excerpt A						no difference						Excerpt B

2. IF you heard a difference between the overall sound of these two performances please indicate which one, if any, of these elements below MOST influenced your perception:

    a. Tempo
    b. Volume
    c. Balance / Blend
    d. Pitch/ Intonation
    e. Tone Quality

Pair #5

1. Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

Excerpt A	5	4	3	2	1	0	1	2	3	4	5	Excerpt B
						no difference						

2. IF you heard a difference between the overall sound of these two performances please indicate which one, if any, of these elements below MOST influenced your perception:

   a. Tempo
   b. Volume
   c. Balance / Blend
   d. Pitch/ Intonation
   e. Tone Quality

Pair #6

1. Comparing the overall sound of the band in these two performances, please indicate your level of preference for Excerpt A and B:

Excerpt A	5	4	3	2	1	0	1	2	3	4	5	Excerpt B
						no difference						

3. IF you heard a difference between the overall sound of these two performances please indicate which one, if any, of these factors below MOST influenced your perception:

   f. Tempo
   g. Volume
   h. Balance / Blend
   i. Pitch/ Intonation
   j. Tone Quality

APPENDIX D:
Participant Response Data

Group	#	Age	Gender	Pair 1 Pref.	Factor	Pair 2 Pref.	Factor	Pair 3 Pref.	Factor	Pair 4 Pref.	Factor	Pair 5 Pref.	Factor	Pair 6 Pref.	Factor
H	1	27	m	0		-2	c	3	c	-1	e	0		0	
H	2	21	f	1	e	-1	a	-1	c	2	e	-2	c	2	c
H	3	21	m	2	c	3	a	-2	a	3	e	-4	d	0	
H	4	21	f	5	c	5	e	2	e	2	c	1	c	1	c
H	5	19	f	3	c	0		-2	b	4	a	-1	d	2	b
H	6	37	m	-5	c	-5	c	-2	e	2	e	-2	e	4	c
H	7	22	m	4	c	-2	c	-3	e	3	d	-2	c	-1	d
H	8	21	f	4	c	-4	c	-5	d	3	e	-4	d	0	
H	9	21	m	0		2	c	3	e	-2	e	-2	b	-2	e
H	10	22	f	0		-2	c	-2	d	1	d	-1	c	0	
H	11	21	f	2	c	0		-4	b	4	b	1	c	0	
H	12	19	m	3	c	0		1	b	2	c	2	e	0	
H	13	18	m	-3	c	2	b	-2	c	0		1	b	-1	c
H	14	22	m	2	e	0		-4	c	2	e	-2	c	0	
H	15	19	m	3	e	-4	c	-4	c	4	c	-5	e	0	
H	16	21	m	3	c	4	e	-3	e	4	c	-5	e	-1	c
H	17	19	f	3	e	2	d	-3	c	4	e	-3	c	-1	d
H	18	21	m	5	c	-3	a	-4	d	4	e	-4	c	0	
H	19	19	m	4	c	-1	c	0		4	d	4	a	-3	a
H	20	20	f	3	e	0		-1	c	2	e	-2	c	0	
H	21	21	m	4	c	4	c	-5	e	4	c	-5	e	-1	e
H	22	20	m	2	c	-2	c	-2	e	-1	c	-2	c	0	
H	23	19	f	2	b	3	e	-3	c	3	c	-1	e	2	e
H	24	21	m	-3	c	3	c	-3	e	3	e	-2	c	0	
H	25	22	f	0		3	e	-3	c	3	d	4	c	2	c
H	26	21	m	1	b	2	c	-2	c	3	b	-3	c	0	
H	27	21	f	-2	c	0		0		1	b	-1	b	-1	b
H	28	21	m	4	c	-2	d	-4	c	3	d	-5	d	-3	e
H	29	19	m	3	c	3	a	3	c	4	e	-3	c	4	e
H	30	23	f	4	c	4	c	-4	e	4	e	-4	e	4	c
H	31	22	m	4	c	-1	c	-4	c	-1	b	1	b	1	c

Group	#	Age	Gender	Pair 1 Pref.	Factor	Pair 2 Pref.	Factor	Pair 3 Pref.	Factor	Pair 4 Pref.	Factor	Pair 5 Pref.	Factor	Pair 6 Pref.	Factor
H	32	22	f	5	c	-4	a	-5	c	5	b	1	b	0	
H	33	20	f	3	c	-4	d	-2	a	5	c	-5	e	1	a
H	34	21	f	-2	c	-3	e	-3	c	-1	d	-3	c	0	
H	36	18	m	3	d	3	d	-5	c	5	c	-5	c	0	
H	37	19	m	0		-3	d	-3	d	-4	c	-5	c	4	c
H	38	21	m	3	c	-3	d	-2	b	2	c	-3	c	0	
H	39	20	f	3	e	2	e	-4	c	3	c	-3	e	-3	e
H	40	20	f	-4	c	1	c	-3	b	3	e	-3	e	-3	c
H	41	18	m	2	c	2	c	-4	c	2	c	-2	c	0	
H	42	19	f	-1	c	2	e	-5	e	4	c	-3	e	1	b
H	43	22	m	4	c	5	d	-5	d	5	e	-5	d	0	
H	44	19	m	2	d	2	c	-3	e	3	c	-1	d	0	
H	45	21	m	3	e	3	e	-3	e	4	c	-4	c	0	
H	46	20	f	3	c	-1	c	-4	e	5	c	-1	e	3	b
H	47	20	f	4	c	2	d	-2	e	2	d	-2	d	-3	d
H	48	30	f	3	c	0		-3	c	3	d	-4	c	1	b
H	49	20	m	-3	c	-2	e	-4	e	-1	d	2	c	1	b
H	50	20	m	0		-3	e	-3	c	1	e	-2	d	1	c
H	51	19	f	-2	d	2	c	-2	c	1	d	-2	e	-1	c
H	52	22	f	4	c	1	e	3	c	-2	c	-1	d	-1	c
H	53	20	m	0		1	c	-2	c	2	c	0		0	
H	54	18	f	-2	c	-1	e	-4	c	4	e	-4	e	0	
H	55	21	f	3	c	-1	b	-2	c	2	c	2	c	0	
H	56	18	m	3	e	-2	e	-3	e	4	c	-3	e	0	
H	57	20	f	1	c	-1	c	-2	b	2	d	-2	c	1	e
H	58	21	m	3	c	-3	e	-3	c	3	c	-2	c	1	c
H	59	19	m	2	c	-1	e	-4	e	2	e	-3	e	2	c
H	60	20	f	2	c	-2	c	-3	c	3	c	-2	c	0	
S	1	20	m	-4	e	-2	e	4	b	1	b	3	b	-3	e
S	2	22	m	2	c	1	e	-2	b	3	b	-2	c	1	e
S	3	21	f	4	c	-1	c	-2	b	1	e	-2	c	0	

Group	#	Age	Gender	Pair 1 Pref.	Factor	Pair 2 Pref.	Factor	Pair 3 Pref.	Factor	Pair 4 Pref.	Factor	Pair 5 Pref.	Factor	Pair 6 Pref.	Factor
S	4	20	f	1	e	-4	b	-4	c	4	d	0		3	a
S	5	20	f	4	c	-4	c	2	d	4	b	4	c	-2	e
S	6	20	f	2	c	1	c	0		-1	c	0		0	
S	7	20	f	-3	b	3	c	-4	c	2	c	-2	c	-1	b
S	8	18	f	-3	c	4	c	-4	e	5	c	-5	e	4	c
S	12	18	m	-2	e	-2	c	-1	e	3	c	-1	c	0	
S	13	30	m	2	c	-2	e	-2	c	2	c	-3	e	-3	c
S	14	22	f	-3	c	-3	c	-5	b	5	c	-5	c	-1	c
S	15	19	f	-2	c	-1	b	2	c	3	c	-1	b	-1	c
S	16	24	m	-2	c	-4	c	-4	c	-3	c	-4	c	-4	c
S	17	23	m	-5	c	-1	e	2	c	4	c	1	e	0	
S	18	21	m	0		2	c	-5	c	3	b	-4	c	3	c
S	19	27	f	-3	c	3	c	-1	c	-2	c	-3	b	-1	c
S	20	24	f	-2	c	2	e	-4	b	4	b	-3	b	-3	c
S	21	29	m	-1	c	-2	c	-1	c	3	e	-4	c	-2	d
S	22	22	m	3	c	-1	c	-2	e	3	c	-3	c	-4	c
S	23	20	m	2	c	0		-3	b	4	e	-1	d	2	e
S	24	23	m	-3	e	-5	c	-5	c	-4	c	-4	c	-5	c
S	25	21	m	1	c	1	c	-3	b	3	b	-3	b	-2	c
S	26	26	m	-4	e	-3	c	-4	c	4	e	-4	e	3	e
S	27	23	m	-3	c	3	c	-4	c	4	c	-4	c	-4	c
S	28	25	m	1	a	1	c	-2	e	1	e	1	a	2	a
S	29	19	m	-2	c	-1	c	-3	e	2	c	-3	c	2	c
S	30	21	m	-3	d	3	e	3	c	3	e	4	d	3	a
S	31	29	m	-3	c	3	d	-2	e	-3	c	-3	c	-3	c
S	32	22	f	-2	e	-3	d	-4	c	2	c	-3	b	-1	d
S	33	29	m	2	c	-2	c	-3	c	3	c	-3	c	-2	c
S	34	25	f	5	c	3	c	-5	b	5	e	-2	c	-1	c
S	35	19	m	-4	c	-4	c	-4	b	4	b	-4	c	3	b
S	36	21	m	3	e	3	e	-4	e	-4	c	4	e	-2	c
S	37	21	m	2	e	3	e	-2	c	3	e	-2	c	2	e

Group	#	Age	Gender	Pair 1 Pref.	Factor	Pair 2 Pref.	Factor	Pair 3 Pref.	Factor	Pair 4 Pref.	Factor	Pair 5 Pref.	Factor	Pair 6 Pref.	Factor
S	38	22	m	1	c	-2	e	-4	c	-1	e	-1	c	0	
S	39	25	f	-3	c	-4	c	3	e	4	c	-2	e	4	c
S	40	21	m	-2	c	1	d	-3	e	3	e	-3	c	3	c
S	41	21	m	-1	b	-1	c	-2	c	0		0		0	
S	42	21	f	-3	c	2	c	-4	e	3	c	-3	e	-3	e
S	46	25	f	-2	c	-4	c	-4	b	1	d	-4	b	-4	b
S	47	22	f	3	e	-2	c	-4	c	4	e	3	d	3	c
S	48	20	m	1	e	-2	c	0		2	e	0		-2	c
S	49	25	m	1	c	-2	c	-4	c	3	b	-4	b	0	
S	50	25	m	-3	c	2	d	-3	b	-3	e	-2	c	3	c
S	51	24	f	-1	e	0		-1	c	1	c	-1	b	1	c
S	52	21	f	-2	c	1	c	-1	c	1	c	-1	d	-1	d
S	53	20	m	-2	e	-3	c	-4	c	3	c	-3	c	-3	c
S	54	21	f	3	c	4	c	-4	c	4	c	-4	c	-5	c
S	55	19	m	-4	e	-4	e	3	b	3	c	-3	e	3	c
S	56	21	m	-3	c	2	b	-4	c	-1	d	-1	b	-3	d
S	57	21	f	-2	c	-1	c	-2	d	2	c	-3	d	-2	e
S	58	21	m	3	c	2	c	-3	e	2	e	-3	c	-3	c
S	59	22	m	3	c	-3	c	-2	b	2	c	-3	c	2	c
S	60	23	m	-3	c	-3	c	-2	c	4	c	-2	e	1	c

REFERENCES

Algazi, V. R., Duda, R. O., Duraiswami, R., Gumerov, N. A., & Tang, Z. (2002). Approximating the head-related transfer function using simple geometric models of the head and torso. *Journal of the Acoustical Society of America, 112*, 2053-2064.

Barron, M., & Marshall, A. H. (1981). Spatial impression due to the early lateral reflections in concert halls: The derivation of a physical measure. *Journal of Sound and Vibrations, 77*, 211-232.

Begian, H. (1997). Experiments in band seating. *Instrumentalist, 52*(5), 65-68.

Berlyne, D. E. (1974). *Studies in the new experimental aesthetics: steps toward an objective psychology of aesthetic appreciation*. New York: Wiley and Sons.

Bourgeois, J. R. (1988). Band Seating Plans. *Band Director Guide, March/April*.

Brittin, R. (1993). Discrimination of aural and visual tempo modulation. *Bulletin of the Council for Research in Music Education, 116*, 23-32.

Brittin, R. (1996). Listeners' preference for music of other cultures. *Journal of Research in Music Education, 44*(4), 328-340.

Brittin, R. (2000). Children's preference for sequenced accompaniments: The influence of style and perceived tempo. *Journal of Research in Music Education, 48*(3), 237-248.

Brittin, R., & Sheldon, D. (1995). Comparing continuous versus static measurements in music listeners' preferences. *Journal of Research in Music Education, 43*(1), 36-46.

Burnsed, V. (1998). The effects of expressive variation in dynamics on the musical preferences of elementary school students. *Journal of Research in Music Education, 46*(3), 396-404.

Colwell, R. J., & Goolsby, T. T. (1991). *The Teaching of Instrumental Music* (2nd ed.). New York: Prentice Hall.

Cooper, L. G. (2004). *Teaching Band and Orchestra: Methods and Materials*. Chicago: GIA Publications Inc.

Curry, R. (1994). Changing seating to suit the music. *Instrumentalist, 49*(5), 56-57.

Daugherty, J. (1996). *Spacing, Formation, and choral sound: preferences and perceptions of auditors and choristers.* Unpublished Doctoral Dissertation, Florida State University, Tallahassee, Florida.

Daugherty, J. (1999). Spacing, formation and choral sound: Preferences and perceptions of auditors and choristers. *Journal of Research in Music Education, 47*(3), 224-238.

Diercks, L. M. (1960). An approach to choral blend and tone. *International Music Educator, 2*(2), 45-47.

Duda, R., O. (2000). 3-D audio for Human/Computer Interaction.   Retrieved March 24, 2006, from http://interface.cipic.ucdavis.edu/CIL_tutorial/3D_home.htm

Duke, R., Geringer, J. M., & Madsen, C. K. (1988). Effect of tempo on pitch perception. *Journal of Research in Music Education, 36*(2), 108-125.

Ekholm, E. (2000). The effect of singing mode and seating arrangement on choral blend and overall choral sound. *Journal of Research in Music Education, 48*(2), 123-135.

Flowers, P. J. (1998). The effects of teaching and learning experiences, tempo, and mode on undergraduates' and chidren's symphonic music preferences. *Journal of Research in Music Education, 36*(1), 19-34.

Furman, C., & Duke, R. (1988). Effect of majority consensus on preferences for recorded orchestal and popular music. *Journal of Research in Music Education, 36*(4), 220-231.

Gale, J. (2001). *The Band Director's Handbook:A Guide for College & Secondary School Music Directors in Southeast Asia*. London: Asean Academic Press Ltd.

Garafolo, R. (1996). *Improving intonation in band and orchestra performance*. Ft. Lauderdale: Meridith Music

Garafolo, R., & Whaley, G. (1976). The symphonic wind ensemble: Seating for sound improvement. *Music Educators Journal, 62*(9), 37-42.

Gardner, M. B. (1968). Historical background of the Haas and/or precence effect. *Journal of the Acoustical Society of America, 43*, 1243-1248.

Geringer, J. M. (1991). Temporal discrimination of modulated intensity in music excerpts and tones. . *Journal of Research in Music Education, 39*(2), 113-120.

Geringer, J. M., & Dunnigan, P. (2000). Listener preferences and perceptions of digital versus analog live concert recordings. *Bulletin of the Council for Research in Music Education, 44*(4), 1-13.

Geringer, J. M., & Madsen, C. K. (1981). Verbal and operant discrimination-- preference for tone quality and intonation. *Psychology of Music, 9*(1), 26-30.

Geringer, J. M., & Madsen, C. K. (1984). Pitch and tempo discrimination in recorded orchestral music among musicinas and nonmusicians. *Journal of Research in Music Education, 32*(3), 195-204.

Geringer, J. M., & Madsen, C. K. (1987). Pitch and tempo preferences in recorded popular music. *Applications of Research in Music Behavior*, 204-212.

Geringer, J. M., & Madsen, C. K. (1998). Musicians' ratings of good versus bad vocal and string performances. *Journal of Research in Music Education, 46*(4), 522-534.

Geringer, J. M., & Worthy, M. (1999). Effects of tone-quality changes on intonation and tone-quality ratings of high school and college instrumentalists. *Journal of Research in Music Education, 47*(2), 135-149.

Gifford, R. M. (1995). Alternative seating solutions. *Instrumentalist, 49*(9), 16-27.

Gregory, D. (1994). Analysis of listening preferences of high school and college musicans. *Journal of Research in Music Education, 42*(4), 331-342.

Hall, E. T. (1966). *The hidden dimension*. Garden City, New York: Doubleday.

Handel, S. (1989). *Listening: an introduction to the perception of auditory events*. Cambridge: The MIT Press.

Hartmann, W., H. (1983). Localization of sound in rooms. *Journal of the Acoustical Society of America, 74*(5), 1380-1391.

Hartmann, W., H. (1999). How we localize sound. *Physics today, November,* 24-29.

Hilliard, H. (2004). Alternative Horn Placement. *The Instrumentalist, October,* 32-34.

Hindsley, M. H. (1976). Seating Arrangements for Concert Band. *The Instrumentalist, May,* 17-21.

Hoover, D. M., & Cullari, S. (1992). Perception of loudness and musical preference: Comparison of musicians and nonmusicians. *Perceptual and Motor Skills, 74*(3, Pt 2), 1149-1150.

Hunsberger, D. (1985). Flexibility- The Name of the Game. *BAND, January/February,* 6-9.

Johnson, C. (1996). Musicians' and nonmusicians' assessment of perceived rubato in muscia performances. *Journal of Research in Music Education, 44*(1), 84-96.
Johnson, W. (1978). Influence of personnel placement on choral blend. *Choral Journal, 18*(9), 12-14.
Killian, J. N. (1990). Effect of model characteristics on music preference of junior high students. *Journal of Research in Music Education, 38*(2), 113-123.
Kistler, D. J., & Wightman, F. L. (1992). A model of head-related transfer functions based on principal components analysis and minimum phase construction. *Journal of the Acoustical Society of America, 91*(3), 1637-1647.
Knapp, M. L., & Hall, J. A. (2002). *Nonverbal communication in human interaction* (5th ed.): Thomson Learning, Inc.
Knutson, B. J. (1988). *Interview with selected choral conductors concerning rationale and practices regarding choral blend.* Unpublished Dissertation, Florida State University, Tallahassee, Florida.
Koury, D. J. (1986). *Orchestral performance practices of the nineteenth century: size proportions and seating* (Vol. 85). Ann Arbor: UMI research press.
Kruth, E. C. (1996). Sound and Seating. *The Instrumentalist, February,* 46-47.
Lambson, A. R. (1961). An evaluation of various seating plans used in choral singing. *Journal of Research in Music Education, 9*(1), 47-54.
Leblanc, A. (1980). Outline of a proposed model of sources of variation in musical taste. *Council for Research in Music Education, 61*, 29-34.
LeBlanc, A. (1981). Effects of style, tempo, and perfromaing medium on children's music preference. *Journal of Research in Music Education, 29*(2), 143-156.
Leblanc, A. (1982). An interactive theory of music preference. *Journal of Music Therapy, 19*(1), 28-45.
Leblanc, A., Chang Jin, Y., Chen-Hafteck, L., Olivera, A., Osthuysen, S., & Tafuri, J. (2000). Tempo preferences of young listeners in Brazil, China, Italy, South Africa and the United States. *Bulletin of the Council for Research in Music Education, 147*, 97-102.
Leblanc, A., Chang Jin, Y., Simpson, C. S., Stamou, L., & McCrary, J. (1998). Pictorial versus verbal rating scales in music preference measurement. *Journal of Research in Music Education, 46*(3), 425-435.
Leblanc, A., Colman, J., McCrary, J., Sherrill, C., & Malin, S. (1988). Tempo preferences of different age music listeners. *Journal of Research in Music Education, 36*(3), 158-168.
Leblanc, A., & Cote, R. (1983). Effects of tempo and performing medium on children's music preference. *Journal of Research in Music Education, 31*(1), 57-66.
Leblanc, A., Jin, Y. C., Stamou, L., & McCrary, J. (1999). Effect of age, country, and gender on music listening preferences. *Bulletin of the Council for Research in Music Education, 141*, 72-85.
Leblanc, A., & McCrary, J. (1983). Effect of tempo on children's music preference. *Journal of Research in Music Education, 31*(4), 283-294.
LeBlanc, A., Sims, W. L., Malin, S., & Sherrill, C. (1992). Relationship between humor perceived in music and preference of differet-age listeners. *Journal of Research in Music Education, 40*(4), 269-282.

LeBlanc, A., Sims, W. L., Siivola, C., & Obert, M. (1996). Music style preferences of different age listeners. *Journal of Research in Music Education, 44*(1), 49-59.
Libbey, T. (1995). Digital versus analog: Digital music on CD reigns as the industry standard. *Omni, 17*(5), 29.
Liversidge, A. (1995). Analog versus digital: Has vinyl been wrongly dethroned by the music industry? *Omni, 17*(5), 28.
Madsen, C. K., & Madsen, K. (2002). Perception and cognition of music: Musically trained and untrained adults compared to sixth-grade and eighth-grade children. *Journal of Research in Music Education, 50*(2), 111-130.
Maiello, A. (1996). *Conducting: A Hands-On Approach*. Miami, FL: Warner Bros. Publications.
Martin, D. L. (1984). Placing the Horns: Thoughts and Opinions from Seven Directors. *The Instrumentalist, August,* 64-65.
McBeth, F. (1972). *Effective performance of band music: solutions to specific problems in the performance of 20th century band music*. San Anotnio: Southern Music Co.
Miles, R. (2004). Improving Performance through "Sound" Seating. In R. Miles (Ed.), *Teaching Music through Performance* (Vol. 5, pp. 72-95). Chicago: GIA Publications Inc.
Montgomery, A. (1996). Effect of tempo on music preferences of children in elementary and middle school. *Journal of Research in Music Education, 44*(2), 134-146.
Page, J. (2004). The Balance and Blend Improve with Different Seating. *The Instrumentalist, March,* 32-34.
Price, H. (1996). Effects of sampled and synthesizer timbres on opinions of musicians and nonmusicians. *Bulletin of the Council for Research in Music Education, 127*, 142-162.
Prince, W. F. (1972). A paradigm for research on music listening. *Journal of Research in Music Education, 20*(4), 445=455.
Radocy, R. E., & Boyle, J. D. (2003). *Pychological foundations of musical behavior* (4th ed.). Springfield, Ill: Charles C. Thomas Publisher, LTD.
Renshaw, J. (2000). Seating bands for the music. *Instrumentalist, 55*(3), 18-23.
Schoenherr, S. (2005). Recording history technology. Retrieved March 20, 2006, from http://history.sandiego.edu/gen/recording/notes.html
Schroeder, M. R. (1993). Listening with two ears. *Music Perception, 10*(3), 255-280.
Schroeder, M. R., Gottlob, D., & Siebrasse, K. F. (1974). Comparative study of European concert halls. *Journal of the Acoustical Society of America, 56*, 1195-1201.
Smith, J. (1988). Band Seating Plans. *Band Director's Guide, January/February,* 28.
Soukhanov, A. H. (Ed.). (2000). *American Heritage Dictionary of the English Language*. Boston: Houghton Mifflin Company.
Stevens, C. (1998). 3-D hearing test. Retrieved March 29 2006, from http://www.waisman.wisc.edu/hdrl/index.html
Strutt, J. W. (1945). *The Theory of Sound* (2nd ed. Vol. 1). London: Macmillan.
Tocheff, R. D. (1990). *Acoustical placement of voices in choral formations.* Unpublished Doctoral dissertation, Ohio State University, Columbus, Ohio.
Wagner. (1994). *Introductory musical acoustics* (3rd ed.). Raleigh: Contemporary Publishing Company of Raleigh Inc.

Wagner, R. (1989). *Wagner on Conducting* (E. Dannreuther, Trans. 1st ed.). Mineloa, NY: Dover Publications Inc.

Wapnick, J., & Rosenquist, M. (1991). Prefernces of undergraduate music majors for sequenced versus performed piano music. *Journal of Research in Music Education, 39*(2), 152-160.

Yarbrough, M. C. (1987). The effect of musical excerpts on tempo discrimination and preferences of musicians and nonmusicians. In C. K. Madsen & C. A. Prickett (Eds.), *Application of Research in Music Behavior*. Tuscaloosa: University of Alabama Press.

BIOGRAPHICAL SKETCH

Name:	Sean Patrick Murray
Birthplace:	Milwaukee, Wisconsin
Education:	Florida State University Tallahassee, Florida Major: Music Education Degree: B.M.E. (1996)
	Florida State University Tallahassee, Florida Major: Music Education Degree: M.M.E. (2003)
	Florida State University Tallahassee, Florida Major: Music Education Degree: Ph. D. (2006)
Experience:	A.J. Ferrell Middle School Tampa, Florda, 1996 Instrumental Music (6-8)
	Hillsborough County Community College Tampa, Florida, 2001-2002 Adjunct Professor, Applied Tuba
	Florida Atlantic University Boca Raton, Florida, 2006 Associate Director of Bands
Honors:	Florida State University Teaching Assistantship: Music Education Pi Kappa Lambda Tau Beta Sigma, Honorary Kappa Kappa Psi, Honorary Phi Mu Alpha