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The purpose of this study was: (a) to investigate the relationship between auditory imagery and representations for action in musical performance and (b) to discuss implications for clarinet playing. The literature reviewed establishes the importance of auditory imagery in instrumental music performance, the importance of mental representations for execution of necessary motor actions in music performance and a possible link between the two. Research is presented which supports the notion that representations of expected sensory feedback may have a role in controlling voluntary motor actions. Expected sensory feedback in musical performance is the auditory image of the desired performance and the proprioceptive feedback from performing the actions necessary for manipulating a musical instrument.

The document concludes with a discussion of the implications of these findings for clarinet playing. Clarinetists must to be able to anticipate the sound they desire to produce and have a corresponding action representation that includes the corresponding feel. While this study focused primarily on clarinet performance, the concepts can easily be applied to all types of musical performance. Musicians need to connect the sound they desire with a "feel" they know will produce that sound.

MENTAL REPRESENTATIONS IN CLARINET PERFORMANCE:

CONNECTIONS BETWEEN AUDITORY IMAGERY

AND MOTOR BEHAVIORS

by

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Problem

The existence of mental representations is widely accepted in psychology, even though the nature and structure of mental representations is controversial. Mental representations are concepts. One's knowledge of the world exists in the form of internal or mental representations. Objects in the world are identified by using mental representations; actions are carried out according to mental representations; events are interpreted through the use of mental representations and knowledge is formed by the creation of mental representations. Markman (1999) and Palmer (1978) present and discuss theories of representation in great detail. Generally, the current study focuses on the existence of mental representations during clarinet performance, specifically mental representations of auditory and motor behaviors.

A common idea in definitions of musical performance is the reproduction of an internal concept or mental representation of music (Hallam, 1998; Kohut, 1992; Lampl, 1996; Matthay, 1913). Mental representation of the music is an auditory image. Kohut (1992) defined musical performance as "the act of producing aesthetically organized sound and silence within time and space. It involves reproduction of musical ideas or concepts (mental images) that are conceived within the musical mind of the performer" (p. 109). This definition implies two distinct, yet related skills for the performer;

technical skills for production of the music and skills of musical understanding. The purpose of this study is: (a) investigate the relationship between auditory imagery and representations for action in musical performance and (b) to discuss the implications for clarinet playing.

Musical performance can be merely the manipulation of an instrument as indicated by the musical notation without reference to any mental representation. Such performances are usually void of depth of expression and display minimal musical understanding. At a minimum, the performance of music requires two dichotomous sets of skills. Musical skills are necessary for understanding and interpreting a musical work, and technical skills are needed to manipulate an instrument to produce the music. Gabrielsson (1999) gives two steps in planning performance.

1. To acquire an adequate mental representation of the piece of music, coupled with a plan for transforming this representation into sounds.
2. To practice the piece to a level that is satisfactory for the purpose at hand. (p. 502)

The act of performing a musical work is the physical recreation of a performer's mental representation of the work. This mental representation is an auditory representation or auditory image. The auditory representation of a musical composition involves the musical set of skills necessary for instrumental performance. The transformation of the auditory image into physical sound involves the technical skills.

Ericsson (1997) lists three types of mental representations that are necessary for expert performance in music. The first representation, desired performance goal, is the internal auditory representation of the music and how the performer intends for the music

to sound. This representation is the equivalent to Gabrielsson's step one listed previously. The second is a representation for executing performance and of the physical actions necessary to produce the first representation, the auditory image. The final is a representation of actual performance, the physical sounds actually produced. This is the music as it is physically experienced by the audience and performer.

Technical development is an undeniable necessity for successful instrumental performance and is the means by which the sound is produced. Technique enables a musical performance, but excellent technique does not ensure a musical performance. The development of technique and musicality in instrumental instruction is a balancing act. Musical development is easily neglected while technical development is emphasized, especially in the early years of private instruction.

Background

Prior to the mid-nineteenth century music was taught aurally by integrating musical and technical skills during instruction (McPherson & Gabrielsson, 2002). Students were expected to improvise, play by ear and compose. During the mid-nineteenth century there was a shift to an emphasis on technical skills (Gellrich & Parncutt, 1998). The development of faster printing and lithograph made printed music cheaper and more readily available. With the increased availability of printed scores in the mid-nineteenth century, instrumentalists began to become specialists in performing music from printed scores (Gellrich & Parncutt, 1998). Exercises that were invented during lessons by teachers and students were no longer used since published exercises were readily available. Students began to play commercially printed exercises rather than

creating their own. The previous aural methods of teaching instruments that included improvisation, playing by ear and composition changed to a focus on technique and interpretation for the reproduction of music from printed scores. The inclusion of improvisation, playing by ear and composition are important to the development of students' musical skills, yet these components of instruction became neglected due to the evolution of the primacy of technical skills.

Aural imagery or inner hearing is considered to be an important aspect of musical development (Dalcroze, 1921/1967; Hallam, 1998; Kohut, 1992) and is a type of mental representation. Ear training courses for undergraduate music students are intended to develop these skills (Benward & Kolosick, 2005; Gottschalk & Kloeckner, 1997; Karpinski, 2000). Dalcroze developed his system of eurhythmics after he concluded his students at the Geneva Conservatory were not able to understand music they were writing because they lacked the ability to hear the music internally (Dalcroze, 1921/1967). Eurhythmics, based on rhythm and movement, includes melodic improvisation and exercises in imaging sound to develop inner hearing of rhythm, melody and harmony.

In addition to representations of the music being performed, representations of the execution of musical performance need development. Musical performance requires motor actions by performers to manipulate the instrument and produce sound. In wind instrument performance, three motor actions; blowing, moving the fingers, and tonguing, are necessary for execution. Each of these three actions occurs outside the field of vision and therefore, knowledge of correct playing is based on feel. Kinesthetic and proprioceptive feedbacks are important. These representations are the basis for

comparison so players know correct action has been taken. They also serve as the referent for the motor actions necessary to produce the desired sounds.

Mental representations for both musical and technical skill sets need development and integration for successful performance. Texts on clarinet playing and teaching focus on the development of technical skills and the mechanics of interpretation but do not address mental representations which are the foundation of both technical and musical performance skills (Campione, 2001; Gingras, 2004; Heim, 1970; Mazzeo, 1990; Moore, n.d.; Pino, 1980; Stein, 1958; Stubbins, 1974; Tosé, 1962; Weston, 1976; Willaman, 1954).

Definition of Terms

Mental representations can be both conscious and unconscious. Imagery is a type of conscious mental representation. The term image is most commonly associated with sense of vision and most research in imagery has focused on visual imagery. Pictures and objects can be imagined; they can be seen in the "mind's eye." But images can occur in all sense modalities. An image is defined as "an internal representation that produces the experience of perception in the absence of the appropriate sensory input" (Wraga & Kosslyn, 2003, p. 466). For a representation to be an image, it must possess certain characteristics. First, the image is not literal. Second is that the image is a construction and synthesis and not merely the reproduction of previous stimuli. A third and important aspect of an image is that it is mentally adjustable. All mental representations are not images, but all images are mental representations.

Auditory imagery is defined as the ability to perceive sound in the absence of the physical presence of sound. Other terms are in use for auditory imagery, including aural imagery, auralization, inner hearing and hearing in the "mind's ear." Martin (1952) suggested the terms "auralize" and "auralization" for the ability to imagine sounds. These terms have not gained widespread usage. Edwin Gordon (2004) coined the term audiation and defines audiation as a process. The audiation process uses auditory imagery and through this process one assimilates and understands the sounds one is hearing (Gordon, 2004).

In addition to auditory imagery, mental representations for action are considered in this study also. Actions are intentional and goal directed processes. The actions involved in instrumental music performance considered in this study involve motor processes and movement. Mental representations for motor processes are generally unconscious, though they can be brought to consciousness through the use of imagery. One can imagine one's self performing an action. Motor programs and motor schemas, discussed in Chapter II, are unconscious mental representations.

Feedback is important in musical performance. Two types of feedback are important in this study, auditory feedback and feedback about the actions of the body. Auditory feedback is self explanatory, but differing terms exist for feedback concerning action and movement of the body. Kinesthesis is the sense of movement of skeletal muscles. Proprioception is a broader term which includes the sense of movement, the cutaneous senses, and the sense of position and orientation of the limbs.

Throughout this study, the ability to create and use mental representations is assumed to be a skill all people possess. Following the assumption that all people have the ability for mental representations and that such representations are a part of normal cognitive activity, the need for development of awareness and usage of mental representations in musical performance will also be assumed.

Statement of Purpose

The purpose of this study is: (a) to investigate the relationship between auditory imagery and representations for action in musical performance and (b) to discuss the implications for clarinet playing. The following chapters will review literature to establish the importance of auditory imagery in musical performance and the importance of mental representations in voluntary motor actions, and to determine possible connections between auditory imagery and motor action in musical performance. The document concludes with a discussion of the implications for clarinet playing.

CHAPTER II

REVIEW OF THE LITERATURE

Auditory Representations

Composers have long believed that aural imagery is important to musical creation. Agnew (1922a) investigated aural imagery usage of major composers of the nineteenth century. She examined and presented statements from the writings of Robert Schumann, Wolfgang Amadeus Mozart, Hector Berlioz, Richard Wagner and Pyotr Tchaikovsky to illustrate imagery usage. Each composer indicated a strong capability for auditory imagery and stressed the importance of auditory imagery for composition and the success of all musicians. Henry Cowell (1926) wrote his own use of auditory imagery in the composition process. For Cowell, the ability to think in sound is a necessity to compose seriously.

> the most perfect instrument in the world is the composer's mind. Every conceivable tone-quality and beauty of nuance, every harmony and disharmony or any number of simultaneous melodies can be heard at will by the trained composer; he can hear not only the sound of any instrument of combination of instruments, but also an almost infinite number of sounds which cannot as yet be produced on any instrument. (Colwell, 1926, p. 234)

He continued by expressing his opinion that ability for strong auditory imagery is developed through training. Colwell based this opinion on his own experience and his knowledge of fellow composers.

Performers also have indicated the importance of aural imagery in instrumental performance. For Schnabel (1942), music existed apart from the score and the instrument. Schnabel wrote that music should precede performance, first the music, then the performance. Payzant (1997) wrote that Glenn Gould had the same philosophy as Schnabel. Gould developed musical images of pieces away from the piano through thought before attempting them at the keyboard.

Trusheim (1987) interviewed twenty-six brass players from five major American orchestras concerning their use of imagery in performance. Twenty-five of those interviewed reported having an aural image of their playing. Those interviewed listed a variety of types of auditory imagery. Some had complex imagery for an ideal tonal concept based on a variety of elements and others based their tonal concept on the sound of another respected player whom they desired to emulate. When playing passages, some would remember an ideal performance by a mentor and attempt to replicate that sound. The aural image is an important part of performance for those who reported using it. This image was what they attempted to reproduce in performance.

Instrumental pedagogues wrote of the importance of developing the ability of students to image music prior to performance (Kohut, 1992; Hallam, 1998; Kemp, 1990). Singing and imitation are the most commonly suggested means for developing an image. Kohut (1992) recommends singing to reinforce the musical image and as a means for determining whether the student's problem is one with a faulty mental image or faulty instrumental technique. Listening to performances by respected musicians is another

method given for developing the aural image by Kohut and by brass players in prominent American orchestras (Trusheim, 1987).

Tobias Matthay (1913) extensively discussed aural imagery in interpretation and performance. He referred to auditory imagery in musical performance as "pre-listening" and "imagination." Matthay stated that these skills are necessary for the student's performance to be enjoyable to the listener. According to Matthay, the responsibility for the development of students' ability to use auditory imagery falls to the teacher.

Caldwell (1990) as well as Connolly and Williamon (2004) included the aural image into the development of a complete image of performance. They wrote that not only should the aural image be developed, but imagery from other sense modalities needs development and integration into a complete image of a successful performance. One should be able to imagine the space in which one will be performing, see oneself perform, imagine the feelings of performing, and so on.

A theory of musical imagery based on pattern constructs was proposed by Fiske (1993). In this theory, pattern constructs are formed upon the learning of a musical pattern. Pattern constructs assume an expectancy profile within the context of a musical language which then allows for the comparison of newly presented patterns to determine whether they are the original pattern, a variant of the original pattern or a uniquely different pattern. According to Fiske, pattern constructs can also be used to generate the pattern or a variant of the pattern in the absence of an external auditory signal. Fiske's theory provides a deeper explanation of Gordon's process of audiation, which uses auditory imagery in the process of musical understanding.

Aleman, Nieuwenstein, Böcker, and de Haan (2000) hypothesized that music training would improve auditory imaging ability. Thirty-five subjects were divided into musically trained and musically untrained groups. Subjects completed three tasks; a musical auditory imagery task, a non-musical auditory imagery task, and a visual imagery task. Results indicate that musical training does improve auditory imaging ability. Subjects with musical training demonstrated significantly better musical auditory imaging ($p < 0.01$) and nonmusical auditory imaging ($p < 0.05$) than subjects who were not musically trained. Visual imaging ability between the groups was essentially the same.

Effective practice is essential to the development of expertise in musical performance and for practice to be effective, recognition of errors must occur. Hallam (2001) studied fifty-five string players ranging in level from beginners to college students. Subjects were recorded while they practiced a short piece for ten minutes which they later performed. Two judges scored the performance and subjects were also interviewed. Results of the study revealed that use of effective strategies depended on the development of aural schemata for monitoring progress and correcting errors. These internal representations can be learned in advance or concurrently with learning a piece of music (Hallam, 1998; 2001).

Bergan (1967) asserted that aural imagery drives artistic performance in music and found a positive correlation between imagery and pitch identification. According to Bergan, the technical production of sound by a musician is directed by an internal aural representation. Woody (1998) presented evidence which supports Bergan's assertion. He

studied the importance of having a performance plan for expressive performance and concluded that a mental representation of the performance goal is necessary for reliable production of an expressive performance. He determined that the more complete a performer's goal representation, the more successful he is at performing music expressively. Performers with expressive performances had representations which were well defined and consciously generated.

Gates and Bradshaw (1974) studied the effects of no auditory feedback and delayed auditory feedback on subjects performing on an electronic organ. Subjects performed under various feedback conditions. They found no difference between immediate feedback and no feedback while delayed feedback and extraneous prerecorded input caused disruption in performance. The authors suggested auditory imagery may guide performance which would account for the lack of statistical difference between the immediate feedback and no feedback conditions. Authors also speculate that delayed auditory feedback and extraneous prerecorded input may interfere with any auditory image that might guide performance.

Action Representations

Motor imagery is part of the representation for the means of production in musical performance. Carl Seashore wrote that motor imagery, in addition to auditory imagery, is important to music performance. "The motor imaginal type is ordinarily also well developed. . . . the motor tendency to image the tone or execute it in inceptive movements is highly developed in the musical mind" (Seashore, 1938/1967, p. 6).

The notion of mental representations for movement is widely accepted. Representations exist at different levels in the motor system and can be either conscious or subconscious. Jeannerod (1995) defines a motor image as a conscious motor representation. The motor image is primarily a kinesthetic representation of the action and "the subject feels himself executing a given action" (Jeannerod 1995, p. 1419). Jeannerod continues, "motor imagery therefore requires a representation of the body as the generator of acting forces, and not only of the effects of these forces on the external world" (1995, p. 1420).

Representations of anticipated sensory feedback resulting from action have been proposed as a means of response selection. The ideo-motor concept of the late nineteenth-century proposed that the idea of an action is all that is necessary to initiate the action. William James was a proponent of this idea. He wrote that all voluntary actions must involve a concept of the effects of the action which exist in memory from prior experience with the action. Actions are associated with their effects. Both kinesthetic effects and other sensory effects are involved in voluntary action as demonstrated in his example; "If I will to utter the word Paul rather than Peter, it is the thought of my voice falling on my ear, and of certain muscular feelings in my tongue, lips and larynx, which guide the utterance" (James 1890/1950, p. 501).

James' writings were based mainly on introspection. More recently, empirical evidence has been presented in support of the role of anticipated sensory feedback in voluntary movement. In his review and discussion of sensory feedback in performance control, Greenwald (1970) presented evidence in support of a contemporary version of

the ideo-motor concept. According to Greenwald, in the ideo-motor mechanism, "an anticipatory image of feedback from an action participates in the selection and initiation or that action" (1970, page 91). Hoffmann, Stoecker and Kunde (2004) also reviewed and presented evidence for the control of behavior through the anticipation of sensory effects. They concluded that both the choice of response and its initiation may be influenced by the anticipated sensory effects.

The coding of actions was studied by Hommel (1996) in a series of experiments. The results of his experiments suggest that action effects have an important role in the formation of cognitive representations of actions. He proposed an action concept model which assumes "that any perceivable effect of an action is automatically processed and cognitively coded, integrated into an action concept, and associated with the motor program that produces both the action and its effects" (Hommel, 1996, p. 185).

Jeannerod (2004) proposed that mental imagery of desired movement exists prior to external movement. This simulated movement contains all the aspects of actual movement but is not executed. Action exists on a continuum from covert to overt. Not all actions reach the overt stage, yet every overt action implies a covert stage.

The closed-loop principle of motor control uses an image of the feedback to guide movement. Greenwald (1970) succinctly defined the closed-loop theory of motor control as:

> A recently accelerating trend in the analysis of skilled performance is to regard the performer as an information processor who compares incoming sensory feedback from responses (reafference) with a stored representation of what feedback from correct performance should be (imaged reafference). Performance control is achieved by the information processor's detecting discrepancies

> between imaged and actual reafference, then generating responses that serve to reduce or eliminate these disparities. (page79)

As cited previously, representations are used to guide the movement and not necessarily in the initiation of the action. Closed-loop control does not assume a representation of the action prior to initiation. In his discussion review of the closed-loop principle of motor control, Greenwald suggests that response images are not vital to closed-loop control. He gives the following examples:

> In tasks such as pointing at a target, tracking a continuously moving object, or singing the pitch that a teacher is singing it is apparent that feedback information is given in the form of discrepancy from an external reference and requires no supplementary internal reference - the pointer and the tracker can see how far they are from their targets, while the singer can hear the interval between his and his teacher's pitch. (page 83)

Concerning the use of an internal reference in the absence of an external reference, he goes on to write "in cases of performance without an external reference, such as a musician giving a solo performance, it would appear that an internal reference is essential to appropriate self-correction of performance" (page 83).

In open-loop movements, a motor program is run after initiation from start to finish. Movement parameters are predetermined and no adjustments are made during execution of the movement. Feedback is compared to a stored representation after completion of the movement and modification of the movement is not possible while it is being executed. In both open-loop and closed-loop motor control, the representation is at the execution level and is used to guide the movement. Schmidt (1975) proposed that these representations may exist in the form of schemas which are combined to form a

program appropriate for completion of the desired actions. The representations and schemas discussed above are subconscious representations of movement.

Relationship of Auditory and Action Representations

Music performance is an audio-motor process when auditory imagery is used to direct performance. Musical notation can generate an auditory image which then can guide musical performance. This type of performance is more musical than simply having notation be a stimulus which results in an action producing a sound without prior knowledge of the desired sound. A link between the auditory image in music and a kinesthetic image has been assumed by several authors (Freymuth, 1999; Galvao & Kemp, 1999; Kohut, 1992; Seashore, 1938/1967).

Studies have found differentiating between auditory and motor imagery to be difficult in music performance tasks. In an functional magnetic resonance imaging, fMRI, study of piano performance and imagery, Meister et al. (2004) investigated the cerebral network which is active during piano performance and imagery of piano performance. They found that networks active in other studies of motor imagery were active in their subjects during the imagery task. While this study did not consider auditory imagery, all but one subject reported hearing the music in their inner ear while imaging the performance and while actually performing.

Petsche, van Stein, and Filz (1996) examined the possibility of detecting activity in the supplemental motor area using electroencephalogram, EEG, in a pilot study. Their subject was a cellist. She spent five minutes listening to a piece of music she knew well, imagining playing the same pieces, and imagining playing scales. One issue identified by

the researchers was "the imagination of playing a music instrument cannot be exactly separated from the imagination of the sound produced, because the EEG changes induced by the imagined movements of playing an instrument are masked by those induced by imagining the sounds produced by it" (p. 122).

In a study of kinesthetics and violin playing, Jacobs (1969) found the following possible relationships between movements and tones produced: right movements produced right tones, wrong movements produced wrong tones, and wrong movements produced right tones. She considered the last of these three to be the most dangerous. The production of the correct tone with the wrong movement requires a change to the means. Students and teachers must direct attention to the means and not only to the tones produced. Students who made such errors in the study had trained musical hearing and relied less on kinesthetic feedback. Students with less trained musical ears make this type of error less and relied more on kinesthetic feedback in playing.

McPherson (1997) found that the cognitive strategies of high-level performers include hearing music before it is played and the ability to "feel" the music physically before performance. Young clarinet students who had better performance skills were able to internally connect sound with fingering. Weaker performers in his study were unable to make this connection. The subjects who performed highest were able to think in sound and translate the notation into sound and transfer what they heard to their instrument displaying both inner hearing and ear-to-hand coordination. McPherson (1997) writes of the highest scoring musician "the link between fingers and singing was automatic and seemed to occur without any conscious effort" (p. 70). The practice techniques used by

the higher achievers in this study included playing by ear, improvising, and mentally rehearsing without the instrument. None of the subjects were instructed by their teachers, who emphasized technical exercises and improvement of repertoire performance, to use these methods.

Holmes (2005) interviewed a cellist and guitarist about their practice strategies and found that auditory, visual, and motor imagery are important in practice. These musicians also used imagery prior to performance. They imagined how the music would sound and the feel of producing the sound prior to playing. The guitarist in her study is quoted as saying, "it's most important not only to know what it should sound like in advance, but be able to characterise what it's going to feel like as well" (p. 225). This musician also uses visual imagery in connection with auditory imagery. His visual imagery is related to movement needed to produce the sound. "It's always in connection with the sound of the music in your head. If I'm thinking of how something sounds, I can see the movements at the same time" (p. 225). Holmes proposes that motor imagery may link interpretive concepts to technique and the sound produced and that interpretation may be central to technical decisions and execution.

Brodsky, Henik, Rubinstein, and Zorman (2003) conducted a set of three experiments in which subjects silently read a score containing an embedded melody. The score was removed and then a melody was played for the subject who then had to identify whether the heard tune was the original melody embedded in the score. Each experiment compared normal nondistracted reading with another reading condition. The first experiment included rhythmic distraction and phonatory interference, wordless singing of

a familiar folksong; the second included listening to a recording of the subject singing a folksong and phonatory interference; and the third compared nondistracted reading with acoustic presentation of the embedded melody. Based on the results of these experiments, the authors determined that phonatory interference impairs notational audiation and concluded that notational audiation may be more closely linked to the inner voice than inner hearing. They proposed that notational audiation, as defined by Gordon, is the silent reading of musical notation resulting in auditory imagery and includes kinesthetic phonatory processes.

Gardner (1990) evaluated the suggestion that management of trumpet embouchure should be guided by pitch imagery. The trumpeter should possess an auditory image of the pitch he desires prior to playing and this image should guide the formation of the embouchure. In his review of psychomotor theory he found support for the suggestion but found little in the pedagogical literature for trumpet to support the idea. Even though trumpet embouchure pedagogy contained nothing which explicitly supported the idea, Gardner concluded that the suggestion is pedagogically sound based on psychomotor theory and general music pedagogy.

Mikumo (1994) found finger tapping to be an effective method for encoding melodies. She had highly musically trained subjects tap fingers as if playing the piano to memorize a melody. The effect of tapping was found to be an effective strategy, especially when the lengths of the melody and retention interval were increased.

Palmer and Meyer (2000) investigated the mental representations for performance and their association with specific motor actions. They studied novice and expert pianists

in a transfer of learning task and determined that as skill level increases; mental plans for performance become disassociated from the necessary movements. They concluded that mental plans for performance of advanced performers are based on pitch relations and not in terms of specific movements.

Mental practice capitalizes on the use of an aural image. The aural image is used in combination with kinesthetic imagery. The two are linked so that the performer becomes aware of how it feels to produce the desired sounds. Ross (1985) demonstrated the effectiveness of mental practice on trombone performance. According to Ross, "mental practice focuses the performer's attention on the cognitive aspects of music performance with less emphasis on the sounds being made. The performer can now think more carefully about what kinds of things might be tried, the consequences of each action can be predicted based on experience, and inappropriate courses of action ruled out" (p. 228). The use of auditory and kinesthetic imagery is important to mental practice according to Ross. "To the extent a performer can "hear" correct pitches and "feel" correct muscular movements when mentally practicing, the combination of physical and mental practice should facilitate music performance" (p. 229).

Freymuth (1999) outlined a method for developing aural and kinesthetic imagery for use during mental practice. She extensively researched the use of imagery and mental practice in both music and sports. Her method enables the user to practice both technical aspects and interpretive aspects of performance. Mental practice involves projecting an aural image of the ideal performance and then attempting to re-create that ideal during actual performance.

The literature reviewed establishes the importance of auditory imagery in instrumental music performance, the importance of mental representations for execution of necessary motor actions in music performance and a link between them. The auditory image can be a guide for the actions necessary for music performance. The auditory image functions as part of the expected sensory feedback resulting from the action of manipulating the instrument. This expected feedback can be used to initiate the corresponding actions which are known to result in that feedback. The action representations also include motor representations which have expected proprioceptive feedback which is the "feel" of the action. Musicians connect the sound they desire with a "feel" they know will produce that sound.

CHAPTER III

CONCLUSIONS

Implications for Clarinet Performance

The purpose of this study was to investigate the relationship between mental representation for the means of production and the mental representation of the desired performance goal in clarinet performance and to discuss the implications for clarinet playing. The preceding review of literature has established the importance of auditory imagery in musical performance, the importance of mental representations in voluntary motor actions and a strong possible connection between auditory imagery and motor actions in musical performance.

Voluntary actions are goal directed. When one decides to perform an action, one has a reason in mind, this reason is the goal. The goal precedes the action. The action is constructed from within and is not necessarily the response to an external stimulus. Two types of input are possible for initiation of action in musical performance, the auditory image or the visual cue of musical notation without reference to an auditory image. The goal of music performance is the reproduction of the internal auditory image. Instrumental musical performance can also be a simpler stimulus-response process. The visual cue of the notes' location on the staff can be connected to the response of specific manipulations of the instrument resulting in a sound without reference to an auditory image or expectation of the sound. According to research and opinion presented

previously, musical notation can result in an auditory image. In this instance, the auditory image resulting from the notation is considered the primary input for the initiation of action. Musical notation can also be the direct stimulus for the initiation of action. The auditory image as initiator of action is preferred for musical performance.

The large volume of literature suggesting the use of an auditory imagery to guide instrumental music performance is supported by the theory of anticipated sensory feedback as a control mechanism for motor actions. An auditory image of the desired performance has been suggested as essential to musical performance by both performers and pedagogues for both musical and technical accuracy. The notion of anticipated sensory feedback as a mechanism for initiation and control of movement is the only type of control where such an image plays a crucial role prior to initiation of movement. As Greenwald (1970) states; "in the closed-loop formulation, the image may serve as a template for comparison with current feedback and need not be activated prior to performance, while the ideo-motor formulation requires the image to be active prior to performance for the purpose of initiating movement" (p. 89).

In musical performance, one must first know the sound one wants to produce. The sound goal of performance is the first representation that needs development. Afterwards, the representation for production of the sound goal can be developed. Instrumental instruction often focuses on the production aspects of performance without developing the sound goal.

The importance of aural imagery usage in music performance has been written about by pedagogues and performers. Learning a piece of music is the development of an

aural image of that work and performance is the reproduction of that image. The ability to hear the music before it is played is the skill that distinguishes the artist/musician from the mere technician. Aural imagery skills can be developed during instruction; yet, clarinet-specific writings do not address aural imagery (Campione, 2001; Heim, 1970; Moore, n.d.; Pino, 1980; Stein, 1958; Weston, 1976; Willaman, 1954). These texts discuss musical concepts in regards to interpretation and provide technical descriptions of how to produce the desired musical effect. Terms such as intuition, talent, and sensitivity are used to vaguely describe musical skills.

The use of auditory imagery for intonation is mentioned in only a few writings on clarinet playing. Tosé (1962), in his discussion of intonation, states that to insure proper intonation the performer must play the pitch as it is heard mentally. The idea of being able to hear a pitch or note before it is played is mentioned by Mazzeo (1990) and Gingras (2004) in discussing development of intonation and the ability to hear pitch relationships. Mazzeo (1990) states the need to hear the next tone prior to playing it in regards to the development of a good legato on the clarinet and also writes that the technical should follow the musical. No explanation or methods for training the ability to internally hear the next note or develop inner hearing are given except for a brief description of methods for improving intonation using electronic tuners and drone pitches.

The clarinet literature is lacking in information on the development of kinesthetic awareness and of any connection between the feel of playing and sound. Perhaps this ability and connection is assumed to be inherent and taken for granted. One author briefly

mentions such awareness in reference to clarinet finger technique. Willaman wrote of the importance of developing "finger consciousness in the mind" (1954, p. 153). The clarinetist should know where his fingers are at all times. Finger consciousness is developed by moving the fingers quickly through a larger distance than one would use during normal playing conditions. Even in this rare mention of "feel" of movement, there is no mention of connecting the feel to the sound produced.

First, one must know what one wants to hear. As one attempts to produce the desired sounds one must be aware of how it feels. When the desired sound is achieved, one can use the knowledge of the feel of production to reproduce the sound. Practicing reproducing the sound and remaining aware of the physical feel helps to commit both the means and the result to memory, allowing for reliable reproduction of the sound in the future. Errors may be sensed in the kinesthetic feedback from the actions which do not have a corresponding error in auditory sensation. Conversely, the musician may be aware of an error present in the auditory sensation which does not correspond with an error in the kinesthetic feedback.

The clarinetist must have a conception of the sound desired, including its timbre, pitch, and dynamic, all parameters influenced by his or her motor actions. The actions are chosen and initiated are based on their associations with the desired sound. These associations are developed over time through experience and practice. A motor program is activated to perform the action necessary to achieve the desired goal. The anticipated feedback in clarinet playing is both auditory and kinesthetic.

Experience playing and memory of what motor actions are required to produce the desired sounds enables the clarinetist to produce the desired sound goal. In the teaching of the clarinet, or any instrument for that matter, it is important for the teacher to guide the student in developing an awareness of the feel of the production of sounds.

Three actions are involved in playing clarinet. These are: blowing into the instrument, moving the fingers and moving the tongue as a method of articulation. Immediately, any clarinetist may notice the lack of embouchure and formation of the oral cavity and throat in this list, but these are included in the larger action of blowing since these are primarily involved in directing the air into the instrument. Each action consists of movements. Blowing is the most important action since it results in the sound which is then manipulated by the other two actions. Blowing into the instrument is also the most complex action of the three. Tonguing is the simplest action, yet may seem to be the most difficult by the clarinetist. Tonguing must not be confused with the broader term of articulation. Articulation is "clarity and distinct rendition in musical performance, whether vocal or instrumental. Correct breathing, phrasing, attack, legato and staccato are some of the aspects in involved" (Apel, 1972, p. 60). Tonguing is one method by which one can articulate. Articulation can be effected by all three actions involved in clarinet playing.

Initial conditions of the action play an important role in clarinet performance. The condition under which one is playing may require modification of the motor output. Conditions effecting modification to response selection include variables such as the room or hall of performance, reed conditions, temperature, humidity, and other

performers. Once again experience with such conditions is important in modifying the actions to achieve the desired goal.

The awareness of "feel" and sound must be developed so that when the clarinetist desires a certain sound he or she knows what it will feel like to produce it. The clarinetist must also be aware of what sound will be produced according to certain feels. This is especially helpful when playing in large ensembles, such as concert bands, where a large number of other clarinetists make it difficult for one to hear one's own sound. In this situation it is necessary to rely on the sense of feel to make sure that the sound being produced is the sound desired by the clarinetist. One can easily adjust to compensate for deficiencies or personally undesirable characteristics in the sounds one hears from other individuals in the ensemble or the composite sound of the section.

An awareness of the correct feel based on desired sound must be developed for each of the three actions in clarinet playing. Galvao and Kemp (1999) gave an example of Pablo Casals teaching in a masterclass. In the masterclass, a student was finding the starting pitch beforehand by playing to find the correct position. Casals had the student practice starting without finding the pitch, just by knowing where the hand placement should be. In clarinet playing, the hands and fingers are at the same place on the instrument all the time. Even though the position of the hands is relatively static and the fingerings more stable, the clarinetist must know the feel of blowing prior to playing.

Many factors are involved in blowing into the clarinet, the act of blowing the air itself along with the formation of the oral cavity, position of the tongue, formation of the embouchure, and position of the jaw. All of these factors are involved in blowing into the

clarinet and have an effect on the resulting sound. As clarinetists know, the higher pitches on the instrument are more malleable than the lower pitches. Stability in the aspects of blowing are necessary for stability of sound in the higher regions of the clarinet. When playing in the higher range of the instrument, especially in the altissimo, the clarinetist needs to be able to place the embouchure prior to beginning the note so that the correct note is attained. An easy example of this need is to play an altissimo note on the clarinet, relax the embouchure, oral formation and throat and notice how little change is necessary for the note to become unacceptable. The same should then be attempted on one of the lowest notes on the instrument. The lower notes will remain acceptable long after changes which rendered the high note unacceptable are surpassed.

While the aspects of blowing are related mostly to tone, timbre and pitch level, finger action is associated more with melodic aspects of playing. The feel of the motion of the fingers must also be developed in relation to the sounds being produced. Willaman (1954) wrote of developing finger consciousness. This awareness of the fingers and their movements in clarinet playing is important and this awareness of the fingers must be cultivated concurrently with awareness of sound. A melody can have an associated motor program. The feel of motion of the fingers during the production of melodies should be cultivated.

Tonguing is one of the most frustrating actions for the clarinetist. Tonguing takes place entirely out of view. Aspects of blowing, such as embouchure, and of fingering can be viewed with a mirror, but to view the action of the tongue requires specialized video equipment not readily available. The feedback for tonguing is sound and feel. Once the

correct sound is achieved the clarinetist must rely on memory of the feel of execution to consistently recreate the intended articulation.

The awarenesses that have been suggested above as needing cultivation in clarinet playing should not be developed in isolation from each other. Playing an instrument requires different independent actions which must work in synergy with each other. While being aware of the details of each component, one must think in terms of the larger action and always be aware of the feel and the sound simultaneously as a whole.

Summary and Suggestions for Future Research

This study investigated the relationship between auditory representations and action representations in musical performance and discussed the implications for clarinet playing. Research has been presented which supports the notion that auditory imagery is vital to musical performance. Evidence has been presented that representations of expected sensory feedback may have a role in controlling voluntary motor actions. Expected sensory feedback in musical performance is the auditory image of the desired performance goal and the proprioceptive feedback from performing the actions. Clarinetists need to be able to anticipate the sound they desire to produce and have a corresponding action representation that includes the corresponding feel. While this study focused primarily on clarinet performance, the concepts can easily be applied to all types of musical performance.

Empirical research is needed to investigate auditory image as a mechanism for motor control in instrumental music performance. How the connections are made and developed between auditory imagery and musical performance technique also need

investigations as well as effective means for the development of these representations, including methods for teaching their usage, must also be investigated.

BIBLIOGRAPHY

Agnew, Marie (1922a). The auditory imagery of great composers. *The University of Iowa Studies in Psychology, 8*, 279-287.

Agnew, Marie (1922b). A comparison of auditory images of musicians, psychologists and children. *The University of Iowa Studies in Psychology, 8*, 268-278.

Aleman, A., Nieuwenstein, M. R., Böcker, K. B. E., & de Haan, E. H. F. (2000). Music training and mental imagery ability. *Neuropsychologia, 38*, 1664-1668.

Apel, W. (1972). *Harvard Dictionary of Music* (2nd ed.). Cambridge, MA: Belknap.

Azzara, C. D. (1993). Audiation-based improvisation techniques and elementary instrumental students' music achievement. *Journal of Research in Music Education, 41*, 328-342.

Benward, B. & Kolosick, J. T. (2005). *Ear Training: A Technique for Listening* (7th ed.). New York: McGraw Hill.

Bergan, J. R. (1967). The relationships among pitch identification, imagery for musical sounds, and musical memory. *Journal of Research in Music Education, 15*, 99-109.

Bradle, S. (1983). Itzhak Perlman. *The Instrumentalist, 37*(6), 14-18.

Brodsky, W., Henik, A., Rubinstein, B., & Zorman, M. (2003). Auditory imagery from musical notation inexpert musicians. *Perception and Psychophysics, 65*, 602-612.

Caldwell, R. (1990). *The Performer Prepares*. Dallas, TX: PST, Inc.

Campione, C. (2001). *Campione on Clarinet*. Fairfield, OH: John Ten-Ten Publishing.

Connolly, C. & Williamon, A. (2004). Mental skills training. In A. Williamon (Ed.) *Musical Excellence* (pp. 221-245). New York: Oxford University Press.

Cowell, H. (1926). The process of musical creation. *The American Journal of Psychology, 37*, 233-236.

Dalcroze, E. J. (1967). *Rhythm, Music, and Education* (H. F. Rubenstein, Trans., Rev. Ed.) Redcourt, England: The Dalcroze Society. (Original work published 1921)

Driscoll, A. (1986). The art of trombone playing: A conversation with Raymond Premru and Ralph Sauer. *The Instrumentalist, 40*(10), 18-24.

Ericsson, K. A. (1997). Deliberate practice and the acquisition of expert performance: An overview. In H. Jørgensen & A. C. Lehmann (Eds.), *Does Practice Make Perfect?: Current Theory and Research on Instrumental Music Practice* (pp. 9-51). Oslo: Norges Musikkhøgskole.

Fiske, H. E. (1993). *Music Cognition and Aesthetic Attitudes*. Lewiston, NY; The Edwin Mellen Press.

Freymuth, M. (1999). *Mental Practice and Imagery for Musicians: A Practical guide for Optimizing Practice Time, Enhancing Performance, and Preventing Injury*. Boulder, CO: Integrated Musician's Press.

Gabrielsson, A. (1999). The performance of music. In D. Deutsch (Ed.), *The Psychology of Music* (2nd ed.) (pp. 501-602). San Diego, CA: Academic Press.

Galvao, A. & Kemp, A. (1999). Kinaesthesia and instrumental music instruction: Some implications. *Psychology of Music, 27*, 129-137.

Gardner, J. E. (1990). The use of pitch imagery in the management of trumpet embouchure: A theoretical consideration. (Doctoral disseration, The University of North Carolina at Greensboro, 1990). *Disseration Abstracts International, 51*, 2916.

Gates, A. & Bradshaw, J. L. (1974). Effects of auditory feedback on a musical performance task. *Perception and Psychophysics, 16*, 105-109.

Gellrich, M. & Parncutt, R. (1998). Piano technique and fingering in the eighteenth and nineteenth centuries: Bringing a forgotten method back to life. *British Journal of Music Education, 15*, 5-24.

Gellrich, M. & Sundin, B. (1993). Instrumental practice in the 18th and 19th centuries. *Council for Research in Music Education, 119*, 137-145.

Gingras, M. (2004). *Clarinet Secrets*: *52 Performance Strategies for the Advanced Clarinetist*. Lanham, MD: Scarecrow Press.

Gordon, E. E. (2004). *The Aural/Visual Experience of Music Literacy: Reading and Writing Music Notation*. Chicago: GIA Publications.

Gottschalk, A. & Kloeckner, P. (1997). *Functional Hearing: A Contextual Method for Ear Training*. New York: Ardsley House.

Greenwald, A. G. (1970). Sensory feedback mechanisms in performance control: With special reference to the ideo-motor mechanism. *Psychological Review, 77*, 73-99.

Gromko, J. E. (2004). Predictors of Music sight-reading ability in high school wind players. *Journal of Research in Music Education, 52*, 6-15.

Hallam, S. (1998). *Instrumental Teaching: A Practical Guide to Better Teaching and Learning*. Oxford: Heinemann.

Hallam, S. (2001). The development of expertise in young musicians: Strategy use, knowledge acquisition and individual diversity. *Music Education Research, 3*, 7-23.

Heim, N. M. (1970). *A Handbook for Clarinet Performance*. Delevan, NY: Kendor Music.

Hoffmann, J., Stoecker, C., & Kinde,W. (2004). Anticipatory control of actions. *International Journal of Sport and Exercise Psychology, 2*, 346-361.

Holmes, P. (2005). Imagination in practice: a study of the integrated roles of interpretation, imagery and technique in the learning and memorisation processes of two experienced solo performers. *British Journal of Music Education, 22*,217-235.

Hommel, B. (1996). The cognitive representation of action: Automatic integration of perceived action effects. *Psychological Research, 59*, 176-186.

Jacobs, C. (1969). Investigation of kinesthetics in violin playing. *Journal of Research in Music Education. 17*. 112-114.

James, W. (1950). *The Principles of Psychology, Vol. 2*, New York: Dover. (Original work published 1890)

Jeannerod, M. (1995). Mental imagery in the motor context. *Neuropsychologia, 33*, 1419-1432.

Jeannerod, M. (2004). Actions from within. *International Journal of Sport and Exercise Psychology, 2*, 376-402.

Karpinski, G. S. (2000). *Aural Skills Acquisition: The Development of Listening, Reading, and Performing Skills in College-Level Musicians*. New York: Oxford University Press.

Kelso, J. A. & Stelmach, G. E. (1976). Central and peripheral mechanisms in motor control. In G. E. Stelmach (Ed.) *Motor control: Issues and trends* (pp. 1- 40). New York: Academic Press.

Kemp, A. (1990). Kinasthesia in music and its implications for developments in microtechnology. *British Journal of Music Education, 7*, 223-229.

Kohut, D. L. (1992). *Musical Performance: Learning Theory and Pedagogy*. Champaign, IL: Stipes Publishing.

Krumhansl, C. L. (1992). Internal representation for music perception and performance. In M. Riess & S. Holleran (Eds.), *Cognitive Bases of Musical Communication* (pp. 197-211). Washington: American Psychological Association.

Kvam, R. & Geidel, S. (Producers). (2005) *The Hasty Legacy* [DVD]. Muncie, IN: Ball State University.

Lampl, H. (1996). *Turning Notes into Music: an Introduction to Musical Interpretation*. London: Scarecrow Press.

Lehmann, A. C. (1997). Acquired mental representations in music performance: Anecdotal and preliminary empirical evidence. In H. Jørgensen & A. C. Lehmann (Eds.), *Does Practice Make Perfect?: Current Theory and Research on Instrumental Music Practice* (pp. 141-163). Oslo: Norges Musikkhøgskole.

Mainwaring, J. (1932). Kinaesthetic factors in the recall of musical experience. *British Journal of Psychology*, *23*, 284-307.

Markman, A. B. (1999). *Knowledge Representation.* Mahwah, NJ: Lawrence Erlbaum Associates.

Martin, D. W. (1952). Do you auralize? *The Journal of the Acoustical Society of America*, *24*, 416.

Matthay, T. (1913). *Musical Interpretation* (6th ed.). Boston: Boston Music Company.

Mazzeo, R. (1990). *The Clarinet*: *Excellence and Artistry*. Medfield, MA: Dorn Publications.

McPherson, G. E. (1997). Cognitive strategies and skill acquisition in musical performance. *Bulletin of the Council for Research in Music Education, 133*, 64-71.

McPherson, G. E. & Gabrielsson, A. & (2002). "From sound to sign." In G. E. McPherson & R. Parncutt (Eds.), *The Science and Psychology of Music Performance* (pp. 99-115). New York: Oxford University Press.

Meister, I. G., Krings, T., Foltys, H., Boroojerdi, B., Müller, M., Töpper, R.,Thron, A. (2004). Playing piano in the mind: An fMRI study on music imagery and performance in pianists. *Cognitive Brain Research, 19,* 219-228.

Mikumo, M. (1994). Motor encoding strategy for pitches of melodies. *Music Perception, 12*, 175-197.

Moore, E. C. (n.d.). The *Clarinet and Its Daily Routine*. Kinosha WI: Leblanc Educational Publications.

Nielsen, S. (1999). Regulation of learning strategies during practice: A case study of a single church organ student preparing a particular work for a concert performance. *Psychology of Music, 27,* 218-229.

Palmer, C. (1997). Music performance. *Annual Review of Psychology, 48,* 115-138.

Palmer, C. & Meyer, R. K. (2000). Conceptual and motor learning in music performance. *Psychological Science, 11,* 63-68.

Palmer, S. E. (1978). "Fundamental aspects of cognitive representation" In E. Rosch & B. B. Lloyd (Eds.), *Cognition and Categorization* (pp. 259-303). Hillsdale, NJ: Lawrence Erlbaum Associates.

Payzant, G. (1997). *Glenn Gould; Music and Mind*. Toronto, Ontario: Key Porter Books.

Petsche, H., von Stein, A., & Filz, O. (1996). EEG aspects of mentally playing an instrument. *Cognitive Brain Research, 3,* 115-123.

Pino, D. (1980). *The Clarinet and Clarinet Playing*. Mineola, NY: Dover.

Reber, A. S. & Reber, E. S. (2001). *Dictionary of Psychology* (3rd ed.). London: Penguin Books.

Rideout, R. R. (1992). "The role of mental presets in skill acquisition" In R. Colwell (Ed.), *Handbook of Research on Music Teaching and Learning* (pp. 472-479). New York: Schirmer Books.

Ross, S. L. (1985). The effectiveness of mental practice in improving the performance of college trombonists. *Journal of Research in Music Education, 33*, 221-230.

Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological Review*, 82, 225-260.

Schmidt, R. A. (1976). The schema as a solution to some persistent problems in motor learning theory. In G. E. Stelmach (Ed.) *Motor control: Issues and trends* (pp. 41-65). New York: Academic Press.

Schmidt, R. A. (1991). *Motor Learning and Performance: From Principles to Practice*. Champaign, IL: Human Kinetics.

Schnabel, A. (1942) *Music and the Line of Most Resistance*. Princeton, NJ: Princeton Unversity Press.

Schumann, R. (n.d.) *Rules for Young Musicians*. Boston: Oliver Ditson Company.

Seashore, C. E. (1967). *Psychology of Music*. Mineola, NY: Dover. (Original work published 1938)

Stein, K. (1958). *The Art of Clarinet Playing*. Princeton, NJ: Summy-Birchard.

Stubbins, W. H. (1974). *The Art of Clarinetistry* (3rd ed.). Ann Arbor, MI: Guillaume Press.

Tosé, G. (1962). *Artistic Clarinet Technique and Study*. Hollywood, CA: Highland Music Company.

Trusheim, G. H. (1991). Audiation and mental imagery: Implications for artistic performance. *Quarterly Journal of Music Teaching and Learning*, *2*, 138-147.

Trusheim, G. H. (1987). Mental imagery and musical performance: An inquiry into imagery use. *Dissertation Abstracts International*. *49*, 04A. (UMI No. 8808237)

Wagner, J. (1985). Larry Combs: A view from the first chair. *The Instrumentalist*, *39*(8), 22-27.

Weston, P. (1976). *The Clarinettist's Companion*. Corby, England: Fentone Music.

Willaman, R. (1954). *The Clarinet and Clarinet Playing: A Text for Beginners, Advanced Players, Listeners*. New York; Carl Fischer.

Woody, R. H., III. (2006). Musicans' cognitive processing of imagery-based instructions for expressive performance. *Journal of Research in Music Eduction*. *54*, 125-137.

Woody, R. H., III. (1998). A study of advanced musicans' mental representations of dynamic (loudness) variations used in expressive music performance (Doctoral dissertation, The Florida State University, 1998). *Dissertation Abstracts International*. *59*, 2414.

Wraga, M. & Kosslyn, S. M. (2003). Imagery. In *The Encyclopedia of Cognitive Science* (Vol. 2, pp. 466-470). London: Nature Publishing Group.