MUSIC AND MOVEMENT: AN INVESTIGATION OF THE INFLUENCE OF FORMAL MUSIC TRAINING AND SIGNIFICANT ATHLETIC EXPERIENCE ON RHYTHMIC PERCEPTION

By

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This document is dedicated to those who have a vested interest in music, sport, and the lifelong pursuit of happiness through successful movement.

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Abstract of Thesis Presented to the Graduate School
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Using the principles of Multiple Intelligence Theory and general concepts of kinesthetic perception, the purpose of this study was to investigate the influence of formal music training and significant athletic experience on rhythmic (temporal) perception. The Rhythm Performance Test Revised was used to determine level of rhythmic ability in musically trained and non-musically trained individuals, as well as athletically trained and non-athletically trained individuals. It was found that those individuals with a combination of formal music training and athletic experience had better rhythmic perception, as compared to those without formal music training or athletic experience. In addition, it was found that participants with team sport experience had better rhythmic perception than those participants with individual sport experience, and there were no differences in rhythmic ability among woodwind, brass, and percussion instrumentalists.

CHAPTER 1
INTRODUCTION

The human body is capable of intricate movements, both large and small. The human body is able to do this through kinesthesia, which is a sense that is comprised of sensory nerves located within the muscles, tendons, and ligaments of the body (Zion, 1996). It is classified in the same category as the other senses: smell, touch, taste, hearing, and sight. Kinesthesia is a sense that is developed over time; as an individual repeats movements, he/she becomes more effective at completing such movements (Zion, 1996). Kinesthesia is also responsible for abstract thinking, as seen in the concepts of organization, logic, invention and creativity (Zion, 1996). Kinesthesia involves the combination of spatial and temporal awareness in completing movements. Spatial and temporal awareness allows an individual to complete even simple tasks, such as picking up a glass of water or kicking a ball.

Temporal awareness can be referred to as rhythmic perception. It is the body's ability to coordinate movement in specific time. Rhythmic perception and spatial awareness work together to help individuals become more aware of "sequencing, linearity, and motion" (Zion, 1996, p. 5). Without these two components, movement becomes jerky and uncoordinated. In addition, kinesthesia involves vestibular awareness and directional awareness. While the research in the area of spatial and vestibular awareness involves much work with athletes, rhythmic perception has yet to be studied (Lejeune, Anderson, Leroy, Thouvarecq, & Jouen, 2004).

Statement of Problem and Purpose of the Study

Several researchers have investigated rhythmic perception from a gross/fine motor skills standpoint, where most of the testing was performed on preschool and elementary school children. While this is important in the examination of the development of motor skills, researchers have not taken into account the long-term effects of training programs. Few studies have taken into account rhythmic abilities and fewer have related this to those with formal music training (Duke, Geringer, & Madsen, 1991; Meeuwsen, Flohr, & Fink, 1998) or significant athletic experience. The current study is designed to relate the importance of rhythmic perception in those with formal music training to those with significant athletic experience, by connecting research topics in the literature concerning Multiple Intelligence Theory, motor development in infants and adolescents as well as older adults, vestibular and spatial awareness in athletes, and temporal awareness studies conducted on musically oriented individuals. The purpose of this study is to investigate the influence of formal music training and significant athletic experience on rhythmic (temporal) perception.

Research Questions

Previous research in music education explains how motor learning can transfer from one piece to the next for experienced pianists, even if the rhythm and notes are different. Palmer and Meyer (2000) found that at advanced skill levels, mental plans become independent from required movements. That is, when taught a particular rhythm on the piano, advanced students were able to transfer that rhythm to different pitches and rhythms. The novice students were only able to transfer this ability when the rhythms were the same. Given this information, the following questions are asked:

- Do participants with formal music training, significant athletic experience, or a combination of both have significantly better rhythmic perception than those participants without any training?

- Do participants with more years of experience in formal music training or with more significant athletic experience have significantly better rhythmic perception that those with less years of formal music training or significant athletic experience?

- Do participants playing a specific type of instrument (woodwind, brass, or percussion) or participants playing a specific type of sport (individual or team sport) have significantly better rhythmic perception?

Hypotheses

With regard to the influence of formal music training on rhythmic perception, it is expected that individuals with formal music training will have better rhythmic perception than non-music trained individuals. The researcher hypothesizes that individuals with significant athletic experience will have heightened rhythmic perception. It is hypothesized that individuals with a combination of formal music training and significant athletic experience will perform better than individuals without formal music training and significant athletic experience, with respect to rhythmic perception. It is also expected that the number of years of participation in formal music training, type of instrument, number of years of participation in significant athletic experiences, and type of sport will influence rhythmic perception. Specifically, those with more years of experience in formal music training or significant athletic experience, as well as those who have experience on a percussion instrument, will have better rhythmic perception than other groups because of the rhythmic nature of the percussion instruments. Also, individuals who compete in individual sports will have better rhythmic perception than those in team sports.

Definition of Terms

The following terms will be referred to frequently in this text, and are defined as follows:

Rhythmic perception is the body's ability to coordinate movement in specific time, consistent with Zion (1996).

Musically trained refers to 5 years or more of music study on a band instrument (woodwind, brass, or percussion). Music study is limited to organized band classes or private lessons.

Significant athletic participation refers to 5 years or more participation in one organized sport at any combination of select, junior varsity, varsity, collegiate, or elite level athletics.

Time signature refers to a sign placed on a staff of music to indicate the meter, commonly a numerical fraction of which the numerator represents the number of beats per measure and the denominator represents the kind of note getting one beat.

Tempo refers to speed at which music is or ought to be played, often indicated on written compositions by a descriptive or metronomic direction to the performer, and is usually expressed in beats per minute.

Assumptions

It is assumed that individuals chosen for the study were randomly chosen by group. That is, the musically trained participants were chosen from a specific larger group, but each individual in the larger group had an equal opportunity to be chosen for the study. The same assumption can be made for non-musically trained individuals. It can also be assumed that participants with formal music training and/or significant athletic experience are accurately and truthfully reporting the number of years they have participated in such activities.

Limitations

One limitation to this study is the composition of the sample. This study limits the definition of musically trained and significant athletic participation. No assumptions can be made about all musically trained individuals (including those involved with string instruments and chorus), thus decreasing its generalizability. The focus of this study was designed with the idea that most musically trained band instrumentalists have experience in coordinating marching and playing simultaneously. In addition, significant athletic participation only included the specific categories listed above with the idea in mind that those individuals received more formal instruction in specific sports.

Significance

Investigating the influence of formal musical training and significant athletic experience on rhythmic perception is important for several reasons. The successful completion of this study may provide a rationale for advocating the importance of music and physical education as components of primary and secondary school curriculum. This goal can be met by filling a gap in the literature. More specifically, very few studies in the literature are concerned with rhythmic perception and the existing works usually test this in music. It is necessary to test in four different groups to demonstrate the relationship between formal music training and significant athletic experience. In addition, this study may serve as the starting point for research in the area of rhythmic perception, as related to athletic experience.

CHAPTER 2
LITERATURE REVIEW

The aim of this chapter is to introduce topics of importance including kinesthesia, Multiple Intelligence Theory (Gardner, 1983), and rhythmic perception. More specifically, components of kinesthetic abilities, background information on Multiple Intelligence Theory, arts and brain development, and rhythmic perception studies involving timing and rhythm interventions for preschool children and children with developmental delay or attention deficit disorders will be addressed.

Kinesthesia

Kinesthesia, in its simplest form, is the awareness of movement and body position (Gabbard, 2004). Kinesthetic abilities, along with visual modalities, are important in the learning and attainment of motor skills. Zion (1996) commented that kinesthesia allows individuals to determine where body parts exist in space and time and how they move in relationship to each other and their environment. Kinesthetic perception involves the reception of input from sensory receptors located all over the body. This input from sensory receptors contrasts with other systems in which information is perceived outside of the body. Kinesthetic perception allows individuals to complete even simple tasks such as walking across a room to pick up a glass of water (Zion, 1996).

Kinesthetic perception is a complex system and, therefore, hard to separate into either a physiological or psychological construct. Instead, an amalgam of systems works jointly to produce kinesthetic perception. The group of receptors that are involved in kinesthetic perception are called the somatosensory system. Proprioceptors are those receptors that reside in the skin, muscles, joints, and in the inner ear. Those receptors that reside in the skin are referred to as cutaneous receptors. Gabbard (2004) introduces a key point with kinesthetic perception: “any one of the kinesthetic receptors in isolation from the other is generally ineffective in signaling information about the movements of the body” (p. 185). Kinesthetic perception, although termed the sixth sense, is the first to develop in the human embryo (Zion, 1996).

The Components of Kinesthetic Perception

Within kinesthetic perception are five sub-categories of perception. They include: body awareness, spatial awareness, directional awareness, vestibular awareness, and rhythmic awareness. The word *awareness* can be used interchangeably with perception. Additionally, rhythmic awareness refers also to rhythmic perception in this review.

Body awareness is an ability to understand and be aware of the different body parts, their relationship to each other, and how they are able to move. According to Gabbard (2004), this awareness is one of the most researched areas associated with kinesthetic perception. He explains that development of body awareness follows the trend to identify major body parts as an infant, then minor body parts by age seven. Identification of body parts begins with verbal cues, while later identification requires auditory memory and motor planning. Gabbard (2004) also explains that the development of this awareness is dependent on linguistic and other sensory abilities.

Spatial awareness refers to the ability to recognize objects in three dimensions (Gabbard, 2004). Moreover, spatial awareness is defined as the relationship between the body in space and the environment that surrounds it. Spatial awareness involves the use of egocentric localization and objective localization, both of which are important in identifying where the body, and its parts, exists in space. Egocentric localization allows an individual to locate objects in space and in reference to themselves. Object localization usually comes after egocentric localization and involves using a focus other than one's self to locate objects. For example, Gabbard (2004) uses the perception of second base in baseball to describe egocentric localization: "an individual might perceive or learn the location of an object relative to him/herself (e.g., second base is directly in front of me when I am batting)" (p. 187). In the object localization frame of reference individuals use landmarks to find second base, as opposed to using the body as a reference.

Directional awareness is referred to as an extension of spatial and body awareness. It involves the ability to sense both sides of the body, identify three-dimensional space, and move the body within that space. Directional awareness is exhibited in infants when they use one hand to pick up an object and the other to play with it (Gabbard, 2004). It is an important aspect of purposeful movement within an environment, and includes the concepts of laterality and directionality. Laterality develops within the first 6 months after birth and becomes more refined around the ages of 5 (Gabbard, 2004). The ability to differentiate between left and right hemispheres of the body allows an individual to relate objects to themselves. Directionality includes the concepts of laterality and spatial orientation and is usually developed by age 4 (Gabbard, 2004).

The fourth component of kinesthetic perception is **vestibular awareness**. Vestibular awareness is based on the idea that to perform any function, an individual must possess a certain amount of balance. Within this awareness are three types of balance: postural, static, and dynamic. Postural balance is the unconscious reflex action that allows an individual to remain upright, including sitting and standing (Gabbard, 2004). Static balance involves maintaining a particular body position when the body is stationary. Dynamic balance involves maintaining posture during movement. Vestibular awareness is important to overall motor development because equilibrium must be achieved before other skills can be acquired (Gabbard, 2004). In addition, it can be a good predictor of overall fundamental gross motor skill in children (Ulrich & Ulrich, 1985).

The final component of kinesthetic perception is **rhythmic awareness**. Rhythmic awareness describes the ability to keep a particular time during movement. Timing in movement encompasses rhythms initiated by the individual and in response to an external rhythm (Gabbard, 2004). Fundamental motor skill acquisition is dependent on some sort of timing or rhythm to be completed successfully. According to Gabbard (2004), the most prevalent movements that involve rhythmic awareness include clapping to music and reproducing those patterns without music.

There is little research available concerning the development of rhythmic awareness, but some studies suggest that this ability improves dramatically by the age of six, then tapers off, improving slightly between early adolescence and adulthood (Gabbard, 2004). The research available mostly deals with intervention programs targeting rhythmic perception for individuals with developmental delay or attention deficit disorders (Kuhlman & Schweinhart, 1999; Shaffer et al., 2001). Others concentrate on the basic developmental timelines for the acquisition of rhythmic ability, testing both adults and young children (Smoll, 1974(a)(b); Volman & Geuze, 1998).

Kinesthetic perception development is the desire to explore an environment and find out more about it. In its simplest sense, kinesthetic perception is exploring the properties of objects by actually picking them up and experimenting with them. Zion (1996) comments: “In order to find out about the properties of many things, we must act on them…We must pick it [a ball] up, squeeze it, drop it, roll it on the floor throw it in the air, bounce it up and down, throw it against the wall, drop it down a stairway, and even kick it” (p. 4). Over time, these explorations are stored and experiences with movement become more automatic. It takes less effort as an adult to walk from place to place because the movement has been stored in the brain and the body has practiced the motion on a regular basis.

Kinesthetic Components Working Together

Haywood and Getchel (2001) group the kinesthetic components together, emphasizing the relationships that exist between different components. As such, the term intermodal perception can be used to describe those relationships. For example, coordination exists between the look and feel of an object. This coordination concept is termed visual-kinesthetic intermodal perception. Visual-kinesthetic intermodal perception may be described by observing mouthing in infants, since the visual and kinesthetic senses give the child a combined view of what they are chewing on (Meltzoff & Borton, 1979). Meltzoff and Borton (1979) found that there was a distinct relationship between oral and visual information.

Another type of coordinated perception is auditory-kinesthetic intermodal perception. This type of perception involves identification of objects through auditory cues. Temple, Williams, and Bateman (1979) tested auditory-kinesthetic intermodal perception by asking children the name of an object or shape and having the children identify through touch the objects that matched the auditory cue. Older children (age 8) were better able to identify objects in this manner than younger children (age 6). Even though the research in this area is limited, studies support the notion that auditory-kinesthetic intermodal perception improves throughout childhood (Haywood & Getchel, 2001).

Research on Components of Kinesthesia in Sport

Within sport and physical activity, research tends to focus on vestibular and spatial awareness. Vestibular awareness is essential for all individuals, but especially in the elderly. As humans age, vestibular awareness decreases and they become more reliant on sight. One group of researchers sought to determine if light physical and sporting activities would improve vestibular awareness and, eventually, decrease incidents of falling (Gauchard, Jeandel, & Perrin, 2001). For this study, researchers evaluated gaze and postural stabilization of three different groups of individuals: low-intensity physical activity participants, high-intensity physical activity participants, and no-activity participants. All participants were in good health and had no history of neurological disorders. Of the three groups, the low-intensity physical activity participants had better postural control and vestibular sensitivity, leading the researchers to believe that practicing low-intensity exercises such as yoga or light gymnastics may improve vestibular awareness and decrease dependence on vision alone (Gauchard, Jeandel, & Perrin, 2001). In a related study, Golomer and Dupui (2000) found that dancers use more proprioception and rely less on vision than untrained participants. Given these two investigations on vestibular awareness, it might also be interesting to test rhythmic awareness to see if such differences exist, since all components of kinesthesia are connected.

Spatial awareness is evaluated in the sport realm with respect to individuals' perception of vertical and horizontal direction. Lejeune and colleagues (2004) attempted to show a linkage between postural vertical and subjective vertical. Postural vertical refers to the orientation of the body in relation to the earth's vertical (Mittelstaedt, 1998). For this study, participants were grouped by sport experience. Two groups had 10 males who participated in soccer or swimming at the collegiate level. The third group included 10 sedentary males who were involved in physical activity less than once per week. Each participant wore opaque glasses which eliminated any visual input. The participants were required to reposition a rod to what they believed was a vertical position. Based on error scores, participation in sport did have some influence on vertical perception (Lejeune et al., 2004a). Similarly, research on body orientation of gymnasts and non-gymnasts revealed that errors of subjective vertical estimates were higher in non-gymnasts, which indicated that perception of body orientation is more influenced by proprioception than through sight (Bringoux et al., 2000).

The components of kinesthetic perception work together to provide a picture of an individual's environment and give an individual the tools to move successfully in a specific environment. Based on the information gathered from research on athletes with regard to vestibular and spatial awareness, it may be possible that similar influences on rhythmic awareness can be appreciated. Along with these physical influences, somatosensory perception, as a part of kinesthesia, can be expressed in different intelligences.

Multiple Intelligence Theory

As there are several components to kinesthetic perception, the ability of an individual to present these components requires certain types of intelligences. Kinesthesia and its related components reside in several areas of the brain, skin, and muscles (Gabbard, 2004). As such, a discussion of the idea of intelligence(s) is required to bridge the gap between the brain and sensory receptors. The following section provides a review of Multiple Intelligence Theory (Gardner, 1983), which will be used as a framework in this study to explain differences in rhythmic perception among different groups of individuals.

History of the Development of Multiple Intelligence Theory

Before Howard Gardner developed Multiple Intelligence theory (Gardner, 1983), he studied developmental psychology and neuropsychology, focusing on how brain damage affected people's abilities. Gardner had always questioned different abilities, mostly those having to do with musicians. In his neuropsychological research, he found that the tasks of singing and speaking could be independent of each other, but when considering signing and speaking, he found that they were indeed related, depending if someone could hear or was deaf (Gardner, 1999).

While working with Harvard's Project Zero, Gardner was able to work with regular and gifted students, attempting to differentiate and understand cognitive development. He tended to focus on artistic entities, including drawing and storytelling. In his work with brain injured patients through Project Zero, he determined that humans were capable of many different things. From this line of questioning, the theory of Multiple Intelligences was born.

Multiple Intelligence (MI) theory was originally proposed by Gardner in his 1983 book, "Frames of Mind." This theory proposes an idea that there is no singular intelligence as is depicted in other intelligence models. According to Armstrong (2000), [Gardner] wanted to break through the barrier of the IQ score and "questioned the validity of determining an individual's intelligence through the practice of taking a person out of his natural learning environment and asking him to do isolated tasks he'd never done before (p. 1)."

MI theory is based on the idea that intelligence is "the capacity to solve problems or to fashion products that are valued in one or more cultural settings" (Gardner & Hatch, 1989). Given this definition, Gardner originally introduced seven intelligences: linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, and intrapersonal. MI theory is driven by both biological and cultural entities. As described by Gardner (1999), intelligence is "a biophysical potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture" (p.33-34).

As such, the following is a brief description of the intelligences and an example of each (Armstrong, 2000):

- **Linguistic intelligence**- the ability to use words effectively, both in writing and orally. Examples include using mnemonics to remember important information, writing poetry or plays, and storytelling.

- **Logical-mathematical intelligence**- the ability to use numbers effectively; also includes understanding logical patterns and relationships, functions, and other abstractions. This intelligence encompasses the ability to calculate or classify information.

- **Spatial intelligence**- the ability to accurately depict relationships between lines, colors, space and form. Examples of this intelligence include a sailor being able to navigate seas in the dark based on constellations, weather, and water depth (Gardner, 1993).

- **Bodily-kinesthetic intelligence**- the ability to use the entire body to express ideas and feelings, as well as using physical skills such as coordination, balance, dexterity, strength, flexibility, speed, proprioceptive, and tactile capacities. Examples for this intelligence are best observed in dancers and athletes.

- **Musical intelligence**- the ability to perceive, discriminate, transform and express musical forms including rhythms, pitch, melody, and tone of pieces of music. This intelligence includes music composition, performance, and critique.

- **Interpersonal intelligence**- the ability to decipher varying moods, motivations and feelings of others. This intelligence is exemplified in individuals who can "read" others well and then use that to convince others to complete certain tasks.

- **Intrapersonal intelligence**- the ability to have knowledge of self and to adapt based on that knowledge. Individuals with this intelligence are better able to see their own strengths and weaknesses as well as how they will react in certain situations.

Gardner has also identified two other intelligences, that of the naturalist and the existentialist. Since these two intelligences are not relevant to the current study, they will not be discussed in this review.

The basic idea of multiple intelligences arose from the understanding that until the 1980s, it was generally perceived that intelligence was "one-dimensional," tested through standardized tests such as the SAT. These tests focused only on the logical-mathematical and linguistic areas because these were considered the core of intelligence. Gardner questioned that perspective and described the work of Robert Sternberg, whose research was based on understanding mental processes. As a researcher in the area of standardized testing, Sternberg questioned IQ tests and their ability to predict intelligence (Gardner, 1999).

Criteria for Identifying the Multiple Intelligences

Certain criteria had to exist in order to differentiate between an actual intelligence and a particular talent or ability. Criteria for the identification of intelligences involved the areas of biological science, logical analysis, developmental psychology, and traditional psychological research. These criteria included the following (Gardner, 1999, p. 36-41):

- "The potential of isolation by brain damage"- During his work as a neuropsychologist, Gardner was always interested in the fact that damage affected some portion of cognition but not another, as in the above example of singing and speaking. Since damage that occurred may only effect one part of the brain, it is assumed that intelligence is separate from others.

- “An evolutionary history and evolutionary plausibility”- Evolutionary theory seeks to explain how certain faculties are used in modern society. By working backwards, theorists are able to see common capacities as they change. An example of this is spatial capacities, in that they may have been used long ago to find ways around the terrain. Today, spatial capacities are observed in the same manner but with many advancements.

- “An identifiable core operation or set of operations”- Each intelligence can be broken down into core operations, that which can be manipulated by internal or external information. Musical intelligence encompasses the operations of deciphering pitch, tone, melody and harmony.

- “Susceptibility to encoding in a symbol system”- Symbol systems can refer to any one of the intelligences, including linguistic, logical-mathematical, or even musical. A symbol system basically encompasses any culturally meaningful information. In music, this would include reading music (notes, key signature, and timing).

- “A distinct developmental history, along with a definable set of expert ‘end-state’ performances”- Any persons exhibiting their intelligence do not do so in simple forms. They exhibit it through whatever the individuals feel is their final goal. Gardner gives an example of a mathematician, who must develop his/her logical-mathematical abilities.

- “The existence of idiot savants, prodigies, and other exceptional people”- Gardner notes the importance of those individuals, like savants, that display certain intelligences without any prior injury to the brain. Autistic individuals display the intelligences in a pure light, as most will have a greater ability to compute, perform music, or build, but lack the ability to communicate verbally or understand others’ intentions. Prodigies are another example of such ability, as they usually excel in one area and are at least average in other areas.

- “Support from experimental psychological tasks”- Studies in psychology that focus on completing two tasks at once are the best way of differentiating what parts of the brain affect movement and cognition. Included in this are studies of transfer and interference.

- “Support from psychometric findings”- Even though MI theory goes against traditional psychometric finding, it is important in identifying the intelligences. Work in this area, including the relationship between spatial and linguistic intelligences, results in the fact that these two entities are separate. This can be used as an argument against the traditional uni-dimensional intelligence.

Once the criteria for the identification of intelligences were set, Gardner was able to describe the seven intelligences listed above. It is important to understand that every person possesses each intelligence, but cultural norms and values determine how those intelligences are presented. Spatial awareness is considered the best example of cultural influence. In one society, spatial awareness could be the ability to navigate by using a map, whereas in other societies it may be represented in the drawings or models of an architect.

Challenges and Criticism of Multiple Intelligence Theory

MI theorists, including Guilford (1967), Thurstone (1947), and Sternberg (1982), all reject the idea that intelligence is a single entity. Most critics of MI theory challenge it with two basic questions: “Is MI a valid representation of the human mind/brain? And how effective is MI as a basis for improving educational outcomes, learning, and personal achievement?” (Shearer, 2004, p.1). Shearer suggests that people who challenge MI theory do so without fully understanding the dynamics. He comments “failure to evaluate assumptions in light of disconfirmatory information and ignorance of the actual facts on the ground” (p.3) as the most common reasons for questioning the theory.

Shearer also restated Gardner’s definition of intelligence and brought three points to the forefront: 1) Intelligence is the ability to solve problems, 2) it is not limited to the capacity for rapid, logical problem solving and convergent thinking, and 3) it does not merely occur in your head. This indicates that the materials and values of the situation are also taken into account (Shearer, 2004). MI theory cannot be directly compared with other intelligence theories because it is multifaceted. Shearer explains that “within each intelligence there are clusters of skill sets that form domains that get expressed and recognized in cultural fields” (p. 4). Each intelligence also had dedicated cerebral structures that are responsible for processing specific information.

Gardner’s comments on singular intelligence include: “I do not deny that g [singular intelligence] exists; instead, I question its explanatory importance outside the relatively narrow environment of formal schooling” (Gardner, 1993, p.39). Gardner also states that neural plasticity, which is the ability of the brain and/or certain parts of the nervous system to change in order to adapt to new conditions, is different from the intelligences and should not be included when speaking of the intelligences.

One of the major critics of MI theory, Perry Klein, asserts that Gardner has two interpretations of Multiple Intelligence Theory, a strong version which suggests that each intelligence works independently of the others, and a weak version which suggests that intelligences work in conjunction (Klein, 1997). Klein believes that no evidence supports the stronger version. Rather, conceptually, MI theory is circular and does not contribute to the enhancement of talents and abilities (Klein, 1997). Klein uses dance as an example by describing how it involves the musical and bodily-kinesthetic intelligences working jointly. Klein then states how Gardner is reluctant to say that all the intelligences are controlled by one central connection (Klein, 1997).

As Klein continues to describe that MI theory is trivial, he explains some of the empirical problems with MI theory. One such empirical problem is in the identification of the intelligences. Gardner’s identification of prodigies and savants allowed him to see the intelligences in their purest form. Among these examples were Yehudi Menuhin, Babe Ruth, and Barbara McClintock (Gardner, 1993). The larger issue with identifying these individuals, who were strong in one particular intelligence, is that their abilities spanned across the intelligences, not just through one. Babe Ruth’s abilities, according to Klein (1997), spanned the bodily-kinesthetic intelligence as well as spatial intelligence. Studies involving transfer of learning also contend that improvement is made across intelligences. Given this information, Klein postulated that it is difficult to grasp which view of MI theory should be taken, the weak or the strong. In either case, the theory does not have enough empirical background to prove that either the strong or weak interpretation is more correct.

Multiple Intelligence Assessment

When creating MI theory, Gardner also emphasized the necessity of alternative assessments including those that test all intelligences using familiar activities. The very nature of MI theory is that each intelligence works in concert with others, and that testing each intelligence independently will not give an accurate picture of a person’s ability to solve problems.

Much opposition to the assessment portion of MI theory has been documented in the literature (Gray & Viens, 1994; Eisner, 1994; Klein, 1997). Plucker, Callahan, and Tomchin (1996) believe that there exists much controversy over assessing based on MI theory, because there is still relatively little research that supports it. Another observation of the controversy of MI theory is that it is believed that performance-based assessment is generally more expensive and harder to administer (Plucker, Callahan, and Tomchin, 1996).

Gray and Viens (1994) describe MI theory as it is applied to multicultural education. The authors explain three cautions with evaluating MI in students from a multicultural perspective. The first caution is that MI theory does not support the notion that certain groups of individuals are fated to perform at specific levels within different intelligences. Intelligences can present themselves in different ways across cultures, which indicates that the same intelligence can be expressed in different areas. For example, spatial intelligence equates with good navigational skills in one culture, but may indicate great artistic skills in another culture. The second caution is that individual and cultural differences cannot just be evaluated once; rather, they need to be assessed on a regular basis to adjust curricular goals for students. Finally, intellectual profiles of students will change over time, so it is imperative for teachers to constantly reassess their students.

Project Spectrum, a venture under Harvard's Project Zero, aimed to develop assessment tasks that would identify many configurations of intelligence (Udall & Passe, 1993). It consisted of 13 performance based activities, teacher ratings, and observational checklists corresponding to four of the multiple intelligences, including spatial awareness. Scoring rubrics were used to determine scores. It was titled the Multiple Intelligence Assessment Technique (MIAT). For the purposes of the MIAT, it was assumed that intelligences work in harmony and children could possess strengths in many intelligences at once. The work done with Project Spectrum supports the use of alternative assessment techniques, especially any that involve performance-based assessments, but the actual research published in this area usually includes a relatively small sample size.

Plucker, Callahan, and Tomchin (1996) were also interested in identifying gifted and talented children. The researchers sought to emphasize one of the many investigations that are currently being carried out using MI theory to identify potential talents. Their study (Plucker, Callahan, & Tomchin, 1996) addressed talent identification components. The main purpose was to “confirm whether a particular set of activities and checklists based on MI theory assess different abilities or intelligences or assess only linguistic and logical-mathematical abilities” and “to determine the reliability and validity of each subscale logically derived from the set of activities” as well as “to assess the gender, ethnic, and school differences on the assessments” (Plucker, Callahan, & Tomchin, 1996, p.83). The subjects in this study were assessed using the MIAT.

A reliability measure of the subscales of the MIAT revealed an alpha of .74 for spatial intelligence. Construct validity measures also indicated that observational scores and teacher rating scales were highly correlated. Differences in gender, ethnicity, and schools revealed that even though effect sizes were small, female students tended to score higher than male students in the linguistic and interpersonal subscales. Asian students scored higher than other ethnic groups on all four subscales.

Additional findings from the study on gifted and talented children included that there were no meaningful differences in gender and that teacher subjectivity may be a reason for the high ratings of Asian students. Alternative assessments prove to be difficult to evaluate because the scores are subjective. Plucker, Callahan, and Tomchin (1996) also commented that Gardner has always been critical of traditional assessment tools because skills are separated, thus it is hard to test his theory. Gardner addresses this issue directly:

> Some critics have suggested that MI theory cannot be disconfirmed . . . If future assessments do not reveal strengths and weaknesses within a population, if performances on different activities prove to be systematically correlated, and if constructs (and instruments) like the IQ explain the preponderance of the variance on activities configured to tap specific intelligences, then MI theory will have to be revamped. (Gardner and Hatch, 1989, p. 8)

Another example of assessment of MI theory is another study that identified gifted and talented children (Fasko, 2001). In this article, authentic assessments including observations and portfolios were described. Fasko (2001) asserts that consideration must be made to ensure that assessments provide for varying response types, include reflection, be contextualized, and track growth over time in order to identify gifted or talented children.

In connection with other defining factors in testing gifted children, Fasko (2001) suggests that using MI theory allows for a more diverse group of individuals to be identified as gifted. Fasko (2001) mentions that Reid and Romanofff (1997) report that there is less socioeconomic bias in MI assessments than in traditional intelligence testing procedures. An increase of 26% of second graders identified as gifted were from low SES families (Fasko, 2001).

MI theory emphasizes using different testing methods other than the traditional manner of taking a child and putting them in an unfamiliar environment and testing them on things they have not learned. Again, Gardner (1993) emphasizes that all intelligences are of equal worth, and that the mathematics and verbal areas are not the only intelligences individuals possess.

Even with the controversy that surrounds Multiple Intelligence Theory, the underlying framework is still important in understanding how individuals interact with their environments. MI theory provides an interesting perspective on the nature vs. nurture issue and has been applied in the pedagogical realm on several levels. MI theory is applied in the classroom as an integrated activity. Specifically, MI theory is currently being integrated into the physical education setting through the use of technology. Videotaping and computers are used to help students see themselves from another’s perspective so that they are better able to understand their body position in space and time (Townsend and Gurvitch, 2002). Music and movement education includes MI theory by allowing a student to improve their spatial, musical, and bodily/kinesthetic intelligences through the use of organized movements as well as improvisational practices in dance (Pica, 1999).

Arts and Brain Development

Relating MI theory to brain development, the arts have some influence on the development of neurobiological systems (Jensen, 2001). While learning can occur without the arts, the process can be greatly improved by utilizing the arts. This is due to the integration of many different brain processes. The arts engage the brain's "integrated sensory, attentional, cognitive, emotional, and motor capacities" (Jensen, 2001, p. 2). Unlike other subject areas, the arts may be difficult to assess because each of these areas of the brain work together.

The arts can be broken down into three categories: musical arts, visual arts, and kinesthetic arts. The musical arts include performance, composition, reading, and analysis of music. This definition is similar to that of the musical intelligence. Kinesthetic arts refers to drama (includes dance, theater, and musicals), industrial (sculpting, auto repair, wood working), and recreational (physical education and sport). Jensen (2001) related the kinesthetic arts to the bodily-kinesthetic intelligence described by Gardner (1983).

According to Jensen (2001) the musical arts have been especially implicated as having an influence in spatial reasoning, creativity, and math skills. In one study (Graziano, Peterson, & Shaw, 1999), students receiving both music and math instruction scored higher than those receiving regular math and reading instruction. It is hypothesized that these higher scores can be attributed to the locations in the brain where problem solving and playing music are connected (Jensen, 2001).

Kinesthetic arts, as a whole, contribute to several areas of brain development and enhancement, specifically with vestibular activation, timing, and perceptual-motor skills (Jensen, 2001). Vestibular activation refers directly to balance. Without the kinesthetic arts, activation of balance can have negative effects in learning, including “attentional deficits, reading problems, emotional problems, weak memory skills, slow reflex skills, lack of classroom discipline, and impaired or delayed writing skills” (Jensen, 2001, p. 77-78). Timing is also present in kinesthetic arts, in the sense of recalling sequences through mental rehearsal. Jensen (2001) describes the process of mental rehearsal with dancers, and reports that dancers have a greater ability to reproduce a routine from memory with an error of less than one percent, when compared to non-dancers with an error of 28 percent. Finally, Jensen (2001) suggests that perceptual motor skills, especially hand-eye coordination, object manipulation, and tracking, can be taught and mastered in older individuals. In addition, exercise can shape muscle fibers for adult activities as well as improve coordination needed in drawing, reading, and writing (Jensen, 2001).

Given the information on the contribution of the arts to brain development, it is important to test musical and kinesthetic(sport) abilities in adults, as it seems logical that with proper training, the brain will be more efficient at demonstrating superior rhythmic abilities.

Rhythmic Perception Studies

Research in rhythmic ability generally focuses on children, from the ages of 3 all the way to adolescence. Within this research area, investigations in beat consistency, origination of beat patterns, and the ability to produce rhythms both “on” and “off” the beat are commonplace. Rhythmic ability is also considered in improving developmental delay and attention deficit disorders.

Timing Studies with Children

Normal movement behavior, including playing sports or a musical instrument, dancing, and other daily activities are dependent on an individual's ability to move to a certain rhythm. Rhythms that are created in daily living include synchronized patterns, which can be defined as an individual producing a pattern that is exactly the same as a given beat. A syncopated pattern, defined as "off" the beat can also exist in rhythm and usually occurs immediately after a given beat. Whether it be synchronized or syncopated, rhythmic ability is equally important in recovery from injury or learning to live with specific diseases, such as Parkinson's (Gabbard, 2004). Tasks involving synchronization have been applied to the area of child development, because it provides an explanation of the development of rhythmic abilities in children (Volman & Geuze, 1998). Using finger taps with an auditory component, Sievers (1932) and Williams (1993) indicated that a child's rhythmic ability increased between the ages of 6 and 12. In studies completed by Smoll (1974, 1975), it was observed that temporal accuracy with respect to arm swinging, increased linearly from ages 5- 11. In these studies, no differences in gender were found (Smoll, 1974, 1975).

Volman & Geuze (1998) sought to take a look at rhythmic abilities with respect to age. Up to the point of this study, syncopation abilities had been tested in adults, but not in children. Volman and Geuze (1998) explain that current research in this field involves the use of the temporal information processing approach. Temporal information processing is regulated by two mechanisms, an internal timekeeper and a sensory feedback mechanism. Synchronization error was defined as the time gap between the onset of tap and metronome event. Volman and Geuze (1998) hypothesized that the relative phase variability of the patterns tested would be smaller in older children and that the critical frequency (the frequency at which loss of stability would be observed) would be higher in older children.

To perform the study, an apparatus was created that included a touch sensitive button built within the surface of the box, which makes a slight noise when pressed. Computer beeps were generated and played for the subjects. When the button was touched, an interruption was recorded on the computer. The children in this study (ages 7, 9, and 11) used their dominant hand and were instructed to coordinate their finger taps with the computer beeps in two different modes: on the beat (in phase) and off the beat (antiphase). Children performed 18 steady state (time stayed the same) trials, took a 5 minute break, then performed 12 scaled frequency (time sped up) trials. Each trial was limited to 32 seconds.

The researchers found that coordination patterns could be performed by all children, except three 7 year olds who were not able to display stable antiphase coordination (Volman & Geuze, 1998). This study supports that rhythmic perception-action coupling can be understood as a pattern formation process and that there are differences between ages for phase variability and critical frequency. The stability of rhythmic perception-action coordination patterns increased with age. Children were more accurate in tapping when the trial contained syncopated rhythms. However, in the scaled frequency trials, children had more difficulty syncopating than synchronizing limb movements to the beat, which was also appreciated in the adult studies (Smoll, 1974, 1975). With this information, it can be assumed that replication of a steady beat by an individual will be well developed by ages 18-23, since beat pattern recognition is said to be mostly developed by the onset of puberty (Volman & Geuze, 1998).

In a related study, Fitzpatrick, Schmidt, and Lockman (1996) suggested that to become proficient at complex rhythmic behaviors, one must be able to bring simpler behaviors under voluntary control. Types of research in this area include movements such as oscillations of two index fingers, an arm and a leg, pendulums held in each hand, legs of two individuals, juggling, finger tapping, and clapping. The researchers chose to test clapping because it is a skill that presents itself fairly early in the development process (between 8 and 12 months) (Fitzpatrick, Schmidt, & Lockman, 1996).

To complete this study, Fitzpatrick, Schmidt, and Lockman (1996) constructed wrist weights as a way to influence inertial loading of the limbs. Using these weights and digitizing equipment, the children's clapping efforts were recorded on high speed cameras as they followed a metronome beat from a computer. The researchers played the beat for a continuous 10 seconds. Five conditions were introduced to differentially load the two wrists. Heavy conditions and light conditions on each wrist, plus one with no weights. Children were asked to clap at three different rates: self chosen, and to a metronome at .88Hz or 2.09 Hz.

Results indicated that children's clapping patterns are relatively coordinated and indicative of a weakly coupled system. By age 7, clapping patterns become more accurate and strongly coupled. It appears that the development of clapping has a large timeline, starting as early as 8 months and not becoming perfected until well into childhood.

Along with the two previous studies mentioned, Semjen, Vorberg, and Schultze (1997) studied how initial synchronization is established. They completed two experiments, both of which involved starting a metronome after the participant had begun self-paced taps. In the first experiment, each participant was instructed to start tapping at their own pace. After a series of taps, the researchers introduced a metronome beat that was equal to the self-paced taps introduced by the participants. In the second experiment, the researchers again instructed the participants to start a beat at their own pace, and then introduced the metronome beat in various speeds compared to the self-paced taps. In both cases, the result was that the participant took at least two taps to catch up with the beat of the metronome. This suggests that period and phase corrections, which both involve tapping before or after a beat, respectively, are used during different tasks and contribute to synchronization of beats in different ways.

The studies completed by Semjen, Vorberg, and Schultze (1997) and Fitzpatrick, Schmidt, and Lockman (1996) give much insight on what would be an effective way of testing rhythmic abilities in individuals. With each of the studies mentioned above, some sort of diagnostic test or instrument was developed. A specific instrument, known as the Rhythm Performance Test-Revised, has been used to identify rhythmic abilities of young children and college students.

Diagnostic Test of Rhythmic Perception

"The objective of making children aware of the steady beat and designing instructions to help students feel the 'heart beat' of the music is basic to many methods of music education" (Meeuwsen, Flohr, & Fink, 1998, p.1). Keeping this in mind, the Rhythm Performance Test-Revised (RPT-R) was originally developed by Dr. John Flohr in 1996. In 1998, a revision included the protocols that test for synchronization with an external beat and tapping of rhythm patterns on the computer (Meeuwsen, Flohr, & Fink, 1998). The test runs via a computer program, using input from the keyboard to record information.

The RPT-R consists of two sections. Part I contains five recordings of an Irish folk song, “Mountain Top” (Meeuwsen, Flohr, & Fink, 1998). Each recording is set to a different tempo, including 110 beats per minute (bpm), 120 bpm, 130 bpm, 140 bpm, and 150 bpm. Part II contains 20 different rhythm patterns that are imitated by the participant. This task is executed through pressing a key on the keyboard, more often the middle of the space bar. During this portion of the test, the participant listens, comprehends, and imitates the rhythm by touching the space bar key on the keyboard. Each rhythm pattern is 1 to 3 measures long and may be in different meter times, such as 2/4, 3/4, 4/4, 6/8, different tempos, such as 60 bpm, 90 bpm, and 130 bpm, and duration of notes, including eighth notes, quarter notes, and quarter rests.

The RPT-R has been validated as a rhythmic perception diagnostic test among 1st-6th grade children (Meeuwsen, Flohr, & Fink, 1998) and college age students (Flohr & Meeuwsen, 2001). It is intended to be used for screening purposes, as well as a pre-test and/or post-test for intervention studies. The original test is an adaptation of the Rhythmic Competency Analysis Test (Weikart, 1989). In the younger children and college age students, reliability coefficients indicate the different parts of the RPT-R to be internally consistent.

Along with the studies completed by Weikart (1989), Meeuwsen, Flohr, and Fink (1998), and Flohr and Meeuwsen (2001), intervention investigations provide insight into the exposure of rhythmic perception and how special attention to this area of kinesthetic ability can help to improve locomotor and object oriented skills as well as improve behavior.

Intervention Studies

Many of the intervention studies in the literature deal with gross and fine motor skills as well as rhythmic perception. Previous studies indicate the importance of developing fundamental motor skills as a step towards more advanced skills and sport specific skills (Burton & Miller, 1998; NASPE, 2002). NASPE (2002) also emphasizes that these skills should be introduced and practiced in primary physical education in order to prevent deficiencies.

Goodway, Crowe and Ward (2003) completed an intervention on preschool children who were deemed at risk for, or already possessed, developmental delay. During a nine week intervention, students who were identified as being at risk or already having a developmental delay completed activities that emphasized locomotor and object control skill performance. A control group, consisting also of at risk preschool children carried out their normal motor skill lessons. Locomotor activities included running, galloping, skipping, and jumping, while object control activities included ball bouncing, striking, kicking, catching, and throwing (Goodway, Crowe, & Ward, 2003). The interventions consisted of 35 minute lessons twice a week, for a total of 10.5 hours of contact. As a result, the children receiving the intervention lessons performed significantly better than the control group when comparing post-test to pre-test, as well as comparing post test between the intervention group and the control group. The intervention described by Goodway, Crowe, & Ward (2003) suggests that children can benefit from rhythmic instruction, even after delay has set in.

In another intervention study, preschool children were again instructed with a specific technique. Zachopoulou, Derri, Chatzpoulou, and Ellinoudis (2003) introduced activities based on “Orff” and “Dalcroze” technique. The authors of this study indicate that according to Thomas and Moon (1976), “rhythmic ability is one of the most coordinated abilities which is considered important for the development, execution, and learning of motor skills (p.51).” It is important to note that up to the point of this study, rhythmic perception has not been researched in depth, even in the realms of physical education and dance.

In the research that has been done in this area, there exists an argument that suggests that rhythmic perception is affected more by maturation than by practice (Haskell, 1993). Many studies are in agreement that the prime age for developing rhythmic perception is between 4 and 7 years (Volman & Geuze, 1998; Fitzpatrick, Schmidt, & Lockman, 1996). That was the primary force driving this particular study.

Before discussing the outcomes of this study on rhythmic perception, it is necessary to explain the techniques used during the intervention. “Orff technique” was developed by Carl Orff and involves “walking, skipping, running, hopping, and jumping…expressed through specific rhythmic movements” (Zachopoulou, Derri, Chatzpoulou, and Ellinoudis 2003). “Dalcroze technique” was developed in 1980, and it involves a movement to music approach called *eurythmics*. In this technique, children are instructed to move creatively to different types of music or temporal stimuli, such as the tap of a tambourine. It targets childrens’ improvisational sense that allows them the opportunity to explore how their body is able to move.

The intervention for this study consisted of classes held twice a week for 10 weeks. Each lesson lasted about 35-40 minutes. During this time, the concept of a steady beat was reinforced as a warm up. Then the children learned improvisation skills and beat patterns using the body (e.g., clapping, foot tapping). The students worked individually and in pairs to recreate patterns made by the teacher, as well as experiment with different instruments to make their own percussive patterns.

Results of this study indicated that the children in the experimental group improved from pre-test to post-test when compared with children who did not receive the treatment. The researchers indicated that more research was needed to be completed in the area of rhythmic perception, and that the specific program used in this study could contribute to the improvement of rhythmic ability in preschool children.

Yet another intervention study involved a computer system, the Interactive Metronome. The Interactive metronome has been validated as a measure of rhythmic ability, as compared to the Test of Gross Motor Ability, and the High/Scope Beat Competency Analysis Test (Kuhlman & Schweinhart, 1999). The purpose of this study was to determine the effect of an intervention, with the Interactive Metronome, on specific aspects of motor and cognitive skills in children with Attention Deficit Hyperactivity Disorder (Shaffer, Jacokes, Cassily, Greenspan, Tuchman, & Stemmer, 2001).

The Interactive Metronome is a patented, PC based interactive version of the traditional music metronome and was developed in 1992. It involves the use of hand and foot sensors and earphones that play a steady beat. The training consists of a user clapping or stomping to specific beat patterns created by the computer. Previous studies indicate that the training improves movement patterns and contributes to academic achievement in children with developmental delay (Stemmer, 1996; Kuhlman & Schweinhart, 1999).

To complete the intervention, the researchers pre-tested males already diagnosed with ADHD, ages 6-12, and randomly assigned them to specific groups. One of those groups received 15 hours of training with the Interactive Metronome®. The other two groups received an intervention using video games or no intervention at all. According to the researchers, “a significant pattern of improvement across 53 or 58 variables favoring the Interactive Metronome treatment was found” (p.155). Additionally, the children involved in the intervention improved motor control, language processing, reading, and regulation of disruptive behavior.

Throughout all of these intervention studies, it is apparent that at the preschool to adolescent age, improvements in motor performance and specifically rhythmic perception can be gained by using specific techniques. This applies to children of different races, ages, developmental skill levels, and special needs.

CHAPTER 3
METHODS

The purpose of this study was to investigate the differences that may exist between musically trained individuals, non-musically trained individuals, individuals with significant athletic experience, and individuals without significant athletic experience. To evaluate these differences, a cross-sectional research design was chosen.

Participants

Participants for this study were purposefully chosen to be included in the following four groups: musically trained without significant athletic experience (MNS), non-musically trained without significant athletic experience (NMNS), non-musically trained with significant athletic experience (NMS), and musically trained with significant athletic experience (MS). All groups were chosen from a large southeastern university. Marching band students were chosen randomly, with no bias for gender, musical instrument, or playing ability. Marching band students were required to have at least 5 years of formal music training on a brass, woodwind, or percussion instrument, but it was not required that they be a music major. Participants with significant athletic experience were chosen randomly as well, with no bias toward gender, sport, or ability. A total of 100 participants were chosen for the study, with the NMNS group containing 30 participants (mean age of 20.0 years), the NMS group containing 33 participants (mean age of 19.9 years), the MNS group containing 22 participants (mean age of 20.1 years), and the MS group containing 15 participants (mean age of 20.1 years). When all groups were combined, the mean age of participants was 20.1 years of age, with a range of 18-23 years of age. In addition, the total sample of participants was 33% male (n=33) and 67% female (n=67). With regard to ethnic background, the total sample was 74% Caucasian (n=74), 3% Hispanic (n=3), 15% African American (n=15), 6% Asian or Pacific Islander (n=6), and 2% other (n=2). With regards to those with formal music training, 28% played a woodwind instrument (n=28), 12% played a brass instrument (n=12), and 6% played a percussion instrument (n=6). Within this group, the mean number of years of experience in formal music training was 3.6 years, with a range of 1-16 years of experience. Of those with significant athletic experience, the mean number of years of experience was 4.8 years, with a range of 1-17 years of experience.

Prior to participating in this study, each participant read, signed, and received a copy of an informed consent agreement approved by the University of Florida's Institutional Review Board.

The Rhythm Performance Test-Revised

The Rhythm Performance Test-Revised (RPT-R) was originally developed by Dr. John Flohr in 1996. In 1998, a revision included the protocols that test for synchronization with an external beat and tapping of rhythm patterns on the computer (Meeuwsen, Flohr, & Fink, 1998). The test runs via a computer program, and uses input from the keyboard to record information.

The RPT-R consists of two sections: Part I contains five recordings of an Irish folk song, "Mountain Top" (Meeuwsen, Flohr, & Fink, 1998). Each recording is set to a different tempo, including 110 beats per minute (bpm), 120bpm, 130bpm, 140bpm, and 150bpm. The participant listened to the recording and tapped the space bar on the computer keyboard corresponding to the tempo of the music. Part II contained 20 different rhythm patterns that are imitated by the participant. This task is executed through pressing a key on the keyboard, most often the middle of the space bar. During this portion of the test the participant listens, comprehends, and imitates the rhythm by touching the space bar key on the keyboard. Each rhythm pattern is 1 to 3 measures long, and may be in different meter times, such as 2/4, 3/4, 4/4, 6/8, different tempos, such as 60 bpm, 90 bpm, and 130 bpm, and duration of notes, including eighth notes, quarter notes, and quarter rests.

The data collected from the RTP-R is in the form of raw scores called constant error (CE) scores and absolute error (AE) scores. Both error scores reflected a participant's tendency to respond to a beat pattern before, during, or after the beat was heard. The constant error score is based on perspectives developed by Dalcroze. There are three perspectives: 1) arrhythmic performance, which is categorized as performance that is spastic and off beat, 2) errhythmic performance, which is performance that has all the notes in the right places, but without flow and time, and 3) eurhythmic performance, which balances the concepts of motion and rhythm.

Constant error scores can be expressed as a negative or positive number, depending on if the participant responds before the beat (negative) or after the beat (positive). When constant error scores are averaged together, the negative and positive scores can cancel each other out, potentially causing those subtle differences to go unnoticed. The absolute error score corrects this by dropping the positive and negative aspects of the raw scores, representing overall error of the participant. In the case of the RPT-R, absolute error scores that are smaller indicate better performance. A percentage of the absolute error scores are also included in the analysis and give the researcher an error score value that can be compared across tempos.

The Rhythm Performance Test-Revised has been validated on children, with a mean age of 8.26 years (Meeuwsen, Flohr, & Fink, 1998), as well as college age students (Flohr & Meeuwsen, 2001). Previous studies, not using this instrument, suggest that performance of a steady beat can be influenced by levels of music participation (Duke, Geringer, & Madsen, 1991). Flohr and Meeuwsen (2001) found that through validation of the Rhythm Performance Test-Revised, type of instruction and major field of study (music major/ non-music major) were influential in the success of synchronizing to a steady beat.

Procedure

Participants in this study reported to the Health Informatics Laboratory on one occasion only. Each participant read and signed an informed consent, as well as filled out a survey containing demographic information. Included in the information collected were age, race/ethnic background, gender, years participating in formal music training, years participating in significant athletic experience, type of significant athletic experience, and type of instrument (brass, woodwind, or percussion). After completing the demographic information, the researcher familiarized each participant with the RPT-R program via a computer. The researcher explained each part of the test and asked the participant if they had any questions. After any questions were answered, the test was administered. Total testing time was about 15 minutes per participant.

Data Analysis

SPSS 12.0 for Windows (SPSS, Inc., Chicago, IL) was used to analyze data produced by the Rhythm Performance Test-Revised. Specifically, absolute error scores (AE) were analyzed, as they are a combination of CE and VE scores. A 1 x 4 (AE scores by assigned group) multivariate analysis of variance (MANOVA) was carried out, specifically investigating the four groups (MS, NMS, MNS, and NMNS) and their main effects. In addition, a 1 x 3 (AE scores x instrument type) ANOVA was carried out to investigate any significant relationships between error scores and type of instrument played. A one-way ANOVA (AE scores x years of experience) was used to determine any significant relationships between error scores and years of experience in formal music training. An independent t-test (AE scores x sport type) was carried out to investigate any significant relationships between error scores and type of sport (i.e., individual or team sport). A one-way ANOVA (AE scores x years of experience) was used to determine any significant relationships between error scores and years of experience in significant athletic activity. If differences were noted, a planned post-hoc analysis using the Tukey test was carried out for the MANOVA and ANOVA analyses.

CHAPTER 4
RESULTS

This section highlights the results of the study, which are organized by hypotheses. As detailed in the previous chapter, participants were separated into four groups; (1) non-musically trained individuals without significant athletic experience (NMNS), (2) non-musically trained individuals with significant athletic experience (NMS), (3) musically trained individuals without significant athletic experience (MNS), and (4) musically trained individuals with significant athletic experience (MS). For each of the statistical analyses presented in this chapter, the dependent variable was rhythmic perception, as measured by absolute error scores (AE) reported from the RPT-R program (Meeuwsen, Flohr & Fink, 1998). Absolute error scores indicate the difference between a given rhythmic beat and a specific participant's tapping, regardless of whether their tapping was before or after the beat. AE scores were further separated into the following two sub-categories; tapping a steady beat and imitating rhythm. All statistical procedures utilized an alpha level of .05 to test for statistical significance.

Hypothesis 1: Rhythmic Perception Based on Grouping

The first hypothesis proposed that the NMS, MNS, and MS groups would have better rhythmic perception than the NMNS group. To test this hypothesis, a one-way multivariate analysis of variance (MANOVA) was conducted, with participant grouping as the independent variable and the AE scores as the dependent variables, thus allowing for the exploration of main effects between the NMNS, MNS, NMS, and MS groups. AE scores included as the dependent variables included each of the 25 separate AE items, the average score of the five-item subcategory measuring abilities to tap a steady beat, the average score of the 20-item subcategory measuring ability to imitate a rhythm, and the average score of the total 25-item scale.

Rhythmic Perception by Group, Total Scale Score

MANOVA results related to the average AE score of the total 25-item measure (RPT-R) indicated a significant main effect between groups ($F(3, 93) = 10.97$, $p = .000$). A planned post-hoc Tukey test indicated that the NMS group ($M=44.48$, $SD=12.17$) performed significantly better than the NMNS group ($M=60.47$, $SD=21.88$, $M_{diff}=15.98$, $p=.001$). Similarly, the MNS group ($M=31.82$, $SD=12.53$) also performed significantly better than the NMNS group ($M=60.47$, $SD=21.88$, $M_{diff}=21.65$, $p=.000$). Additionally, results indicated that the MS group ($M=36.07$, $SD=15.66$) performed significantly better than the NMNS group ($M=60.47$, $SD=21.88$, $M_{diff}=24.40$, $p=.000$).

Rhythmic Perception by Group, Tapping the Steady Beat

MANOVA results also indicated significant main effects between participant groups in terms to the five AE scores related to tapping a steady beat. Indeed, significant main effects between groups were evident in all five aforementioned individual AE scores: tapping at 110bpm ($F(3, 93) = 3.99$, $p = .010$); tapping at 120bpm ($F(3, 93) = 7.12$, $p = .000$); tapping at 130bpm ($F(3, 93) = 5.22$, $p = .000$); tapping at 140bpm ($F(3, 93) = 9.72$, $p = .000$); and tapping at 150bpm ($F(3, 93)= 6.18$, $p = .001$). Moreover, when the five AE scores related to tapping were combined into an average AE score of tapping abilities, there remained a significant main effect between participant groups ($F(3, 93)= 11.90$, $p = .000$).

To isolate the location of differences between groups, planned post-hoc Tukey tests were performed. In terms of the AE score measuring tapping at 110bpm, results of a

Tukey test indicated the only significant difference to be that the MNS group (M= 27.73, SD= 113.95) performed significantly better than the NMNS group (M=28.86, SD=11.81, M_{diff}= 60.57, p= .016). Tukey tests relating to the AE score for tapping at 120bpm indicated that the NMNS group (M= 81.00, SD= 74.82) performed significantly lower than the NMS group (M= 37.58, SD= 28.17, M_{diff}= 43.42, p= .003), the MNS group (M= 34.68, SD= 27.36, M_{diff}= 46.21, p= .004), and the MS group (M= 26.21, SD= 7.61, M_{diff}= 54.79, p= .003). Similarly, Tukey tests relating to the AE score F(3, 93) for tapping at 130bpm indicated that the NMNS group (M= 56.60, SD= 46.57) performed significantly lower than the NMS group (M= 34.00, SD= 25.45, M_{diff}= 22.60, p= .025), the MNS group (M= 28.73 , SD= 11.75 ,M_{diff}= 27.87, p= .009), and the MS group (M= 26.07, SD= 13.09, M_{diff}= 30.53, p= .014). In terms of tapping at 140bpm, results of the Tukey test were similar to the aforementioned AE scores and indicated that the NMNS group (M= 56.80, SD= 39.28) performed significantly lower than the NMS group (M= 29.65, SD= 16.77, M_{diff}= 27.15, p= .000), the MNS group (M= 27.64, SD= 11.79,M_{diff}= 29.16, p= .000), and the MS group (M= 23.21, SD= 10.31, M_{diff}= 33.59, p= .000). Finally, Tukey tests relating to the AE score for tapping at 150bpm indicated that the NMNS group (M= 50.87, SD= 49.24) performed significantly lower than the NMS group (M= 24.35, SD= 11.66, M_{diff}= 26.51, p= .003), the MNS group (M= 24.68, SD= 10.67,M_{diff}= 26.51, p= .003), and the MS group (M= 20.57, SD= 8.42, M_{diff}= 30.30, p= .009).

As mentioned above, the five individual AE scores assessing tapping ability were averaged to provide an indication of overall tapping abilities. A planned post-hoc Tukey test procedure was also implemented to isolate the location of between group differences on the overall AE score indicated by the MANOVA. Results of the Tukey test indicated that, as with the majority of individual AE tapping scores, the NMNS group (M= 66.67, SD= 46.62) performed significantly lower than the NMS group (M= 34.65, SD= 15.98, M_{diff}= 32.02, p= .000), the MNS group (M= 28.73, SD= 8.19, M_{diff}= 37.94, p= .000), and the MS group (M= 24.86, SD= 6.97, M_{diff}= 41.81, p= .000). Remaining between group comparisons did not indicate significant differences. Means and standard deviations for all tapping variables can be found in Table 4.1.

Rhythmic Perception by Group, Imitating Rhythms

MANOVA results also indicated significant main effects between participant groups in terms of the 20 AE scores related to imitating rhythms. Indeed, significant main effects between groups were evident in rhythm imitation in 2/4 meter at 90bpm (AE6) (F(3, 93) = 6.18, p = .001), in 2/4 meter at 90bpm (AE14) (F(3, 93) = 5.51, p = .002), 2/4 meter at 130bpm (AE11) (F(3, 93)= 2.74, p = .047), and in 2/4 meter at 130bpm (AE24) (F(3, 93) = 2.71, p = .050). Moreover, when all 20 AE scores related to rhythm imitation were combined into an average AE score of rhythm imitation abilities, there remained a significant main effect between participant groups (F(3, 93) = 5.19, p = .002).

To isolate the location of differences between groups, planned post-hoc Tukey tests were performed. In terms of the AE score measuring rhythm imitation in 2/4 meter at 90bpm (AE6), results of a Tukey test indicated that the NMNS group (M= 66.33, SD= 40.41) performed significantly lower than the NMS group (M= 39.97, SD=32.00, M_{diff}= 26.37, p= .009), the MNS group (M=33.68, SD= 19.70, M_{diff}=32.65, p= .002), and the MS group (M= 34.71, SD= 23.68, M_{diff}= 31.62, p= .014). Tukey tests relating to the AE score for rhythm imitation in 2/4 meter at 90bpm (AE14), indicated that the NMNS group (M= 147.30, SD= 113.87) performed significantly lower than the MNS group (M= 72.77, SD= 37.65, M_{diff}= 74.53, p= .011), and the MS group (M= 54.50, SD= 36.47, M_{diff}=

92.80, p= .005). For rhythm imitation in 2/4 meter at 130bpm (AE11), results of a Tukey test indicated that there were no specific differences among participant groups. Tukey tests relating to the AE score for rhythm imitation in 2/4 meter at 130bpm (AE24), indicated that the MS group (M=5.92, SD= 14.80) performed significantly better than the NMS group (M= 40.45, SD= 43.67, M_{diff}= 34.52, p= .041).

As mentioned above, the 20 individual AE scores assessing rhythm imitation ability were averaged to provide an indication of overall rhythm imitation abilities. A planned post-hoc Tukey test procedure was also implemented to isolate the location between group differences on the overall AE score indicated by the MANOVA. Results of the Tukey test indicated that the NMNS group (M=58.97, SD= 25.28) performed significantly lower than the MNS group(M= 41.36, SD= 14.94, M_{diff}= 17.60, p= .008), and the MS group (M= 38.93, SD= 18.37, M_{diff}= 20.04, p= .009).

Remaining between group comparisons did not indicate significant differences. Means and standard deviations for all rhythm imitation variables can be found in Table 4.2.

Table 4-1. Mean AE scores by group, tapping phase

Variable	Group	Mean	S.D.
AE1	NMNS	88.3	114
	NMS	47.5	54.6
	MNS	27.7	11.4
	MS	28.9	11.8
AE2	NMNS	81.0	74.8
	NMS	37.6	28.2
	MNS	34.7	27.4
	MS	26.2	7.61
AE3	NMNS	56.6	46.6
	NMS	34.0	25.5
	MNS	28.7	11.8
	MS	26.1	13.1

Table 4-1. Continued

Variable	Group	Mean	S.D.
AE4	NMNS	56.8	39.3
	NMS	29.7	16.8
	MNS	27.6	11.8
	MS	23.2	10.3
AE5	NMNS	50.9	49.2
	NMS	24.4	11.7
	MNS	24.7	10.7
	MS	20.6	8.42
AE1-5	NMNS	66.7	46.62
	NMS	34.7	15.98
	MNS	28.7	8.19
	MS	24.9	6.97

Table 4-2. Mean AE scores by group, rhythm imitation phase

Variable	Group	Mean	S.D.
AE6	NMNS	66.3	40.4
	NMS	40.0	32.0
	MNS	33.7	19.7
	MS	34.7	23.7
AE7	NMNS	65.9	41.4
	NMS	52.4	43.5
	MNS	44.0	26.1
	MS	39.2	18.4
AE8	NMNS	38.2	31.5
	NMS	32.6	23.6
	MNS	20.9	12.9
	MS	28.8	19.4
AE9	NMNS	53.0	45.1
	NMS	34.4	25.0
	MNS	36.4	19.8
	MS	32.3	14.2
AE10	NMNS	94.7	75.0
	NMS	54.3	45.0
	MNS	69.7	99.4
	MS	49.0	71.8
AE11	NMNS	79.3	62.3
	NMS	59.1	44.3
	MNS	46.6	35.5
	MS	44.6	27.2
AE12	NMNS	57.8	29.2
	NMS	46.9	28.3
	MNS	51.3	26.3
	MS	35.0	22.8

Table 4-2. Continued

Variable	Group	Mean	S.D.
AE13	NMNS	66.5	34.9
	NMS	53.4	30.9
	MNS	46.8	35.7
	MS	48.1	24.1
AE14	NMNS	147	114
	NMS	118	88.3
	MNS	72.8	37.7
	MS	54.5	36.5
AE15	NMNS	88.7	71.5
	NMS	66.1	57.4
	MNS	54.7	47.1
	MS	49.6	54.8
AE16	NMNS	46.0	44.8
	NMS	39.9	39.6
	MNS	44.0	36.7
	MS	28.7	20.4
AE17	NMNS	61.2	50.6
	NMS	47.0	41.4
	MNS	44.4	36.5
	MS	51.1	61.6
AE18	NMNS	19.9	26.2
	NMS	29.2	28.3
	MNS	24.1	18.6
	MS	31.3	26.8
AE19	NMNS	24.2	29.8
	NMS	29.5	33.0
	MNS	28.8	28.0
	MS	41.9	33.8
AE20	NMNS	72.2	52.66
	NMS	60.1	47.1
	MNS	54.0	34.13
	MS	43.9	28.27
AE21	NMNS	35.0	58.88
	NMS	24.5	40.58
	MNS	24.2	26.57
	MS	26.5	30.01
AE22	NMNS	56.7	66.82
	NMS	39.9	38.92
	MNS	40.1	53.05
	MS	24.6	16.34
AE23	NMNS	20.2	49.34
	NMS	25.3	44.86
	MNS	24.3	33.89
	MS	37.9	55.32

Table 4-2. Continued

Variable	Group	Mean	S.D.
AE24	NMNS	36.3	45.57
	NMS	40.5	43.67
	MNS	26.4	35.96
	MS	5.93	14.8
AE25	NMNS	48.8	52.62
	NMS	44.9	49.19
	MNS	39.6	43.38
	MS	69.1	50.08
AE6-25	NMNS	59.0	25.28
	NMS	46.8	15.09
	MNS	41.4	14.94
	MS	38.9	18.37

Hypothesis 2: Rhythmic Perception Based on Instrument or Sport Type

The second hypothesis proposed that the percussionist groups would have better rhythmic perception than the woodwind and brass instrumentalist groups. To test this hypothesis, a one-way analysis of variance (ANOVA) was conducted, with instrument type grouping as the independent variable and the AE scores as the dependent variables, thus allowing for the exploration of main effects between the woodwind, brass and percussion instrumentalist groups.

In addition, the second hypothesis also proposed that the participants involved in individual sports would have better rhythmic perception than participants involved in team sports. To test this hypothesis, an independent t-test was conducted, with sport type grouping as the independent variable and the AE scores as the dependent variables, thus allowing for the exploration of differences between the individual and team sport groups.

AE scores included as the dependent variables included each of the 25 separate AE items, the average score of the five-item subcategory measuring abilities to tap a steady beat, the average score of the 20-item subcategory measuring ability to imitate a rhythm, and the average score of the total 25-item scale.

Rhythmic Perception by Instrument Type and Sport Type, Total Scale Score

ANOVA results related to the average AE score of the total 25-item measure (RPT-R) indicated no significant main effect between the groups for the RPT-R as a whole ($F(2, 43) = .737$, $p = .485$). T-test results to the average AE score of the total RPT-R also indicated no significant differences between individual and team sport groups for the RPT-R as a whole ($t(67) = .151$, $p = .880$).

Rhythmic Perception by Instrument Type and Sport Type, Tapping the Steady Beat

ANOVA results indicated no significant main effects between instrument types in tapping at 110bpm($F(2, 43) = .293$, $p = .748$), tapping at 120bpm($F(2, 43) = 2.905$, $p = .066$), tapping at 130bpm($F(2, 43) = 1.53$, $p = .229$), tapping at 140bpm($F(2, 43) = .013$, $p = .987$), and tapping at 150bpm($F(2, 43) = 2.422$, $p = .101$). Moreover, when the five AE scores related to tapping scores were combined into an average AE score of tapping abilities, no significant main effects were found between instrument type groups (($F(2,43) = .386$, $p = .682$).

T-test results indicated no significant main effects between sport types in tapping at 110bpm($t(68) = 1.96$, $p = .05$), tapping at 120bpm($t(68) = 1.55$, $p = .126$), tapping at 130bpm($t(68) = 1.86$, $p = .067$), tapping at 140bpm($t(68) = 1.81$, $p = .074$), and tapping at 150bpm($t(68) = .706$, $p = .483$). Moreover, when the five AE scores related to tapping scores were combined into an average AE score of tapping abilities, there remained significant main effects (($t(66) = 2.19$, $p = .032$). For the combined tapping phase of the RPT-R, results of the t-test indicated that the team sport group ($M = 34.91$, $SD = 23.12$) performed significantly better than the individual sport group ($M = 52.60$, $SD = 43.63$, $p =$

.032). Means and standard deviations for all tapping variables can be found in Tables 4.3 and 4.5.

Rhythmic Perception by Instrument Type and Sport Type, Imitating Rhythms

ANOVA results indicated no significant main effects between instrument types in terms of the 20 AE scores related to rhythm imitation. Moreover, when the 20 AE scores related to rhythm imitation scores were combined into an average AE score of rhythm imitation, there remained no significant main effects (($F(2, 42) = .599$, $p = .554$).

T-test results indicated significant differences between sport types in terms of the 20 AE scores related to rhythm imitation in 2/4 meter at 90bpm (AE16) ($t(68) = 2.56$, $p = .013$) and in 2/4 meter at 90bpm (AE19) ($t(68) = 3.32$, $p = .001$). Moreover, when the 20 AE scores related to rhythm imitation were combined into an average AE score of rhythm imitation, there remained no significant main effects. For rhythm imitation in 2/4 meter at 90bpm (AE16), results of the t-test indicated that the team sport group (M= 47.27, SD= 32.35) performed significantly lower than the individual sport group (M= 24.31, SD= 42.03, p= .013). For rhythm imitation in 2/4 meter at 90bpm (AE19), results of the t-test indicated that the team sport group (M= 40.25, SD= 32.54) performed significantly lower than the individual sport group (M= 15.38, SD= 25.89, p= .001).

Remaining between group comparisons for instrument type groups and sport type group did not indicate significant differences. Means and standard deviations for all rhythm imitation variables can be found in Tables 4.4 and 4.6.

Table 4-3. AE Means by Instrument Type, Tapping Phase

Variable	Group	Mean	S.D.
AE1	Woodwind	49.71	110.23
	Brass	32.83	15.98
	Percussion	24.50	7.94

Table 4-3. Continued

Variable	Group	Mean	S.D.
AE2	Woodwind	28.29	10.62
	Brass	25.42	14.58
	Percussion	48.33	49.01
AE3	Woodwind	31.32	15.83
	Brass	28.25	11.69
	Percussion	20.33	7.55
AE4	Woodwind	27.64	19.24
	Brass	27.50	15.02
	Percussion	28.83	9.91
AE5	Woodwind	24.79	11.50
	Brass	22.42	10.06
	Percussion	14.33	5.13
AE1-5	Woodwind	33.48	28.19
	Brass	27.33	10.68
	Percussion	27.17	11.62

Table 4-4. AE Means by Instrument Type, Rhythm Imitation Phase

Variable	Group	Mean	S.D.
AE6	Woodwind	53.18	41.80
	Brass	49.33	49.64
	Percussion	26.33	11.40
AE7	Woodwind	40.07	23.99
	Brass	49.17	34.65
	Percussion	38.33	13.81
AE8	Woodwind	48.00	31.58
	Brass	45.58	35.95
	Percussion	35.67	10.41
AE9	Woodwind	65.93	40.84
	Brass	70.00	54.58
	Percussion	80.83	40.75
AE10	Woodwind	65.04	51.67
	Brass	44.67	46.32
	Percussion	59.50	57.50
AE11	Woodwind	53.68	41.60
	Brass	51.50	35.59
	Percussion	39.17	18.30
AE12	Woodwind	22.21	36.14
	Brass	50.67	51.41
	Percussion	27.00	10.71
AE13	Woodwind	45.61	50.49
	Brass	33.83	30.48
	Percussion	18.33	15.37

Table 4.4. Continued

Variable	Group	Mean	S.D.
AE14	Woodwind	29.96	46.56
	Brass	14.42	29.90
	Percussion	23.67	29.71
AE15	Woodwind	17.64	30.66
	Brass	24.75	46.47
	Percussion	37.50	41.62
AE16	Woodwind	40.00	25.13
	Brass	36.33	46.14
	Percussion	28.00	9.86
AE17	Woodwind	51.57	36.05
	Brass	47.25	41.38
	Percussion	39.33	10.69
AE18	Woodwind	27.71	19.35
	Brass	27.33	33.36
	Percussion	26.50	8.22
AE19	Woodwind	35.18	18.98
	Brass	36.67	29.23
	Percussion	26.83	12.29
AE20	Woodwind	73.11	98.58
	Brass	41.17	41.76
	Percussion	29.00	12.05
AE21	Woodwind	38.46	35.49
	Brass	42.33	43.77
	Percussion	21.83	18.29
AE22	Woodwind	47.36	50.11
	Brass	41.75	30.69
	Percussion	51.67	53.16
AE23	Woodwind	21.18	17.11
	Brass	25.92	31.18
	Percussion	31.83	14.47
AE24	Woodwind	36.75	36.44
	Brass	26.08	27.23
	Percussion	19.50	10.67
AE25	Woodwind	47.04	45.96
	Brass	33.92	43.14
	Percussion	63.00	33.38
AE6-25	Woodwind	44.59	17.35
	Brass	39.67	25.70
	Percussion	36.33	7.20

Table 4-5. AE Means by Sport Type, Tapping Phase

Variable	Group	Mean	S.D.
AE1	Individual	63.15	76.99
	Team	38.45	25.89
AE2	Individual	62.81	78.19
	Team	41.41	37.15
AE3	Individual	48.35	53.98
	Team	31.55	20.38
AE4	Individual	42.35	37.82
	Team	29.27	22.65
AE5	Individual	36.27	32.99
	Team	30.11	36.48
AE1-5	Individual	52.60	43.63
	Team	34.91	23.12

Table 4-6. AE Means by Sport Type, Rhythm Imitation Phase

Variable	Group	Mean	S.D.
AE6	Individual	49.50	40.08
	Team	42.00	25.29
AE7	Individual	48.15	33.95
	Team	52.82	41.13
AE8	Individual	26.38	23.53
	Team	35.36	21.77
AE9	Individual	37.85	39.91
	Team	40.09	22.53
AE10	Individual	53.62	45.58
	Team	63.75	59.94
AE11	Individual	57.92	41.66
	Team	56.93	41.60
AE12	Individual	50.64	36.50
	Team	43.43	23.27
AE13	Individual	55.65	33.07
	Team	51.75	26.88
AE14	Individual	112.88	88.30
	Team	115.48	110.19
AE15	Individual	56.31	54.54
	Team	74.45	59.26
AE16	Individual	24.31	42.03
	Team	47.27	32.35
AE17	Individual	45.50	55.75
	Team	52.07	44.95
AE18	Individual	21.46	26.11
	Team	27.32	25.67

Table 4.6. Continued

Variable	Group	Mean	S.D.
AE19	Individual	15.38	25.89
	Team	40.25	32.55
AE20	Individual	56.12	51.89
	Team	60.43	39.21
AE21	Individual	20.77	35.68
	Team	28.95	41.08
AE22	Individual	36.58	54.13
	Team	37.98	38.57
AE23	Individual	21.92	45.83
	Team	32.57	54.19
AE24	Individual	35.46	41.81
	Team	30.39	41.66
AE25	Individual	50.12	50.84
	Team	51.32	51.71
AE1-5	Individual	52.60	43.63
	Team	34.91	23.12

Hypothesis 3: Rhythmic Perception Based on Years of Experience

The third hypothesis also proposed that individuals with more years of experience in formal music training would have better rhythmic perception than individuals with fewer years of experience. Again, years of experience were divided into three groups, based on measures of central tendency. To test this hypothesis, a one-way analysis of variance (ANOVA) was conducted, with years of experience as the independent variable and the AE scores as the dependent variables, thus allowing for the exploration of main effects between 0-4 years, 5-8 years, and 9+ years of experience. AE scores included as the dependent variables included each of the 25 separate AE items, the average score of the five-item subcategory measuring abilities to tap a steady beat, the average score of the 20-item subcategory measuring ability to imitate a rhythm, and the average score of the total 25-item scale.

In addition, the third hypothesis proposed that individuals with more years of significant athletic experience would have better rhythmic perception than individuals with fewer years of significant athletic experience. Years of experience were divided into three groups, based on measures of central tendency. To test this hypothesis, a one-way analysis of variance (ANOVA) was conducted, with years of experience as the independent variable and the AE scores as the dependent variables, thus allowing for the exploration of main effects between 0-4 years, 5-8 years, and 9+ years of experience. AE scores included as the dependent variables included each of the 25 separate AE items, the average score of the five-item subcategory measuring abilities to tap a steady beat, the average score of the 20-item subcategory measuring ability to imitate a rhythm, and the average score of the total 25-item scale.

Rhythmic Perception by Years of Experience, Total Scale Score

ANOVA results related to the average AE score of the total 25-item measure indicated a significant main effect between years of significant athletic experience ($F(2, 97) = 6.55$, $p = .002$). Results indicated a significant main effect between years of experience in formal music training for the RPT-R as a whole ($F(2.97) = 3.24$, $p = .043$).

To isolate the location of differences between years of significant athletic experience, planned post-hoc Tukey tests were performed. For the total RPT-R, results of a Tukey test indicated no specific differences between groups. To isolate the location of differences between years of experience in formal music training, planned post-hoc Tukey tests were performed. For the total RPT-R, results of a Tukey test indicated 9+ experience group ($M = 35.28$, $SD = 11.49$) performed significantly better than the 0-4 years experience group ($M = 51.48$, $SD = 18.88$, $M_{diff} = 16.21$, $p = .002$).

Rhythmic Perception by Years of Experience, Tapping the Steady Beat

ANOVA results also indicated significant main effects between the years of significant athletic experience groups in terms of the five AE scores related to tapping to a steady beat. Indeed, significant main effects between groups were evident in tapping at 120bpm($F(2, 97) = 4.35$, $p = .016$), tapping at 130bpm($F(2, 97) = 3.18$, $p = .046$), tapping at 140bpm($F(2, 97) = 5.58$, $p = .005$), and tapping at 150bpm($F(2, 97) = 4.46$, $p = .014$). When the tapping scores were combined, significant main effects were also found (($F(2, 96) = 3.24$, $p = .043$).

To isolate the location of differences between the years of significant athletic experience groups, planned post-hoc Tukey tests were performed. For tapping at 120bpm, results of the Tukey test indicated that the 9+ experience group (M= 45.95, SD= 18.94) performed significantly better than the 0-4 years experience group (M= 61.59, SD= 64.08, M_{diff}= 32.70, p= .031). For tapping at 130bpm, results of the Tukey test indicated that the 9+ experience group (M= 24.29, SD= 19.07) performed significantly better than the 0-4 years experience group (M= 44.69, SD= 38.89, M_{diff}= 20.40, p= .041). Tukey tests relating to the AE score for tapping at 140bpm indicated that the 0-4 years experience group (M= 44.78, SD= 34.11) performed significantly lower than the 5-8 years experience group (M= 26.32, SD= 8.96, M_{diff}= 18.46, p= .012) and the 9+ years experience group (M= 27.52, SD= 22.10, M_{diff}= 17.26, p= .040). For tapping at 150bpm, results of the Tukey test indicated that the 9+ years experience group (M= 20.90, SD= 13.17) performed significantly better than the 0-4 years experience group (M= 40.25, SD= 40.20, M_{diff}=19.35, p= .038).

As mentioned above, the five individual AE scores assessing tapping ability were averaged to provide an indication of overall tapping abilities. A planned post-hoc Tukey test procedure was also implemented to isolate the location of between years of significant athletic experience differences on the overall AE score indicated by the ANOVA. Results of the Tukey test indicated that the 5-8 years experience group (M= 31.21, SD=10.95) performed significantly better than the 0-4 years experience group (M= 50.90, SD= 40.62, M_{diff}= 19.69, p= .023).

ANOVA results indicated significant main effects between the years of experience in formal music training groups in terms of the five AE scores related to tapping to a steady beat. Indeed, significant main effects between the years of experience in formal music training groups were evident in tapping at 120bpm($F(2, 97) = 4.12$, p = .019), tapping at 130bpm($F(2, 97) = 3.40$, p = .037), and tapping at 140bpm($F(2, 97)$ = 4.68, p = .011). When the tapping scores were combined, significant main effects were also found (($F(2, 96) = 4.29$, p = .016).

To isolate the location of differences between the years of experience in formal music training, planned post-hoc Tukey tests were performed. For tapping at 120bpm, results of the Tukey test indicated that the 9+ experience group (M= 24.58, SD= 10.11) performed significantly better than the 0-4 years experience group (M= 58.25, SD= 59.78, M_{diff}= 33.68, p= .028). For tapping at 130bpm, results of the Tukey test indicated that the 9+ experience group (M= 24.05, SD= 13.09) performed significantly better than the 0-4 years experience group (M= 43.98, SD= 38.93, M_{diff}= 19.92, p= .05). Tukey tests relating to the AE score for tapping at 140bpm indicated that the 0-4 years experience group (M= 41.34, SD= 31.85) performed significantly lower than the 5-8 years experience group (M= 34.89, SD= 21.26, M_{diff}= 21.71, p= .008).

As mentioned above, the five individual AE scores assessing tapping ability were averaged to provide an indication of overall tapping abilities. A planned post-hoc Tukey test procedure was also implemented to isolate the location of between years of experience in formal music training differences on the overall AE score indicated by the ANOVA. Results of the Tukey test indicated that the 5-8 years experience group (M= 32.59, 18.25) performed significantly better than the 0-4 years experience group (M= 52.47, SD= 21.00, M_{diff}= 23.79, p= .015).

Remaining between group comparisons did not indicate significant differences. Means and standard deviations for all tapping variables can be found in Tables 4.7 and 4.9.

Rhythmic Perception by Years of Experience, Imitating Rhythms

ANOVA results also indicated significant main effects between the years of significant athletic experience groups in terms of the 20 AE scores related to imitating rhythms. Indeed, significant main effects between the years of significant athletic experience groups were evident in rhythm imitation in 2/4 meter at 90bpm (AE6) ($F(2, 97) = 3.95$, $p = .022$). Moreover, when the 20 rhythm imitation scores were combined, no significant main effects were found (($F(2, 96) = 1.38$, $p = .256$).

To isolate the location of differences between the years of significant athletic experience groups, post-hoc Tukey tests were performed. In terms of the AE scores measuring rhythm imitation in 2/4 meter at 90bpm (AE6), results of the Tukey test indicated that the 9+ experience group (M= 29.95, SD=22.63) performed significantly better than the 0-4 years experience group (M= 53.39, SD= 36.61, M_{diff}= 23.44, p= .020).

ANOVA results indicated significant main effects between the years of experience in formal music training groups in terms of the 20 AE scores related to imitating rhythms. Indeed, significant main effects between the years of experience in formal music training groups were evident in imitating rhythm in 2/4 meter at 90bpm (AE14) ($F(2, 97) = 8.43$, $p = .000$), in imitating rhythm in 2/4 meter at 90bpm (AE22) ($F(2, 97) = 3.41$, $p = .037$), imitating rhythm in 2/4 meter at 130bpm (AE24) ($F(2, 97) = 5.31$, $p = .007$). Moreover, when the when the 20 rhythm imitation scores were combined, significant main effects were also found (($F(2, 96) = 4.30$, $p = .016$).

To isolate the location of differences between the years of significant athletic experience groups, planned post-hoc Tukey tests were performed. In terms of the AE score measuring rhythm imitation in 2/4 meter at 130bpm (AE11) indicated that the 9+ experience group (M= 36.79, SD= 23.51) performed significantly better than the 0-4 years experience group (M= 67.40, SD= 52.58, M_{diff}= 30.61, p= .040). For imitating rhythm in 2/4 meter at 90bpm (AE14), results of the Tukey test indicated that the 0-4 years experience group (M= 138.58, SD= 107.07) performed significantly lower than the 5-8 years experience group (M= 74.84, SD= 46.51, M_{diff}= 63.74, p=.019) and the 9+ years experience group(M= 55.21, SD= 30.37, M_{diff}= 83.37, p= .001). For imitating rhythm in 2/4 meter at 90bpm (AE22), results of the Tukey test indicated that the 5-8 years experience group (M= 55.68, SD= 55.32) scored significantly lower than the 9+ years experience group (M= 16.32, SD= 15.70, M_{diff}= 39.37, p= .042). For imitating rhythm in 2/4 meter at 130bpm (AE24), results of the Tukey test indicated that the 0-4 years experience group (M= 40.66, SD=44.64) performed significantly lower than the 9+ years experience group (M= 9.00, SD=24.93, M_{diff}= 31.66, p= .008). As mentioned above, the 20 individual AE scores assessing rhythm imitation ability were averaged to provide an indication of overall tapping abilities. A planned post-hoc Tukey test procedure was also implemented to isolate the location of between group differences on the overall AE score indicated by the MANOVA. Results of the Tukey test indicated that the 9+ years experience group (M= 37.89, SD= 14.16) performed significantly better than the 0-4 years experience group (M= 52.47, SD= 21.00, M_{diff}= 14.58, p= .018).

Remaining between group comparisons did not indicate significant differences. Means and standard deviations for all tapping variables can be found in Tables 4.8 and 4.10.

Table 4-7. AE Means by Years of Significant Athletic Experience, Tapping Phase

Variable	Group	Mean	S.D.
AE1	0-4 years	63.33	92.16
	5-8 years	35.25	26.05
	9+	45.95	62.60
AE2	0-4 years	61.51	64.08
	5-8 years	36.21	27.71
	9+	28.81	18.94
AE3	0-4 years	44.69	38.89
	5-8 years	34.86	24.49
	9+	24.29	19.07
AE4	0-4 years	44.78	34.11
	5-8 years	26.32	8.96
	9+	27.52	22.10
AE5	0-4 years	40.25	40.20
	5-8 years	23.57	10.48
	9+	20.90	13.17
AE1-5	0-4 years	50.90	40.62
	5-8 years	31.21	10.95
	9+	32.58	18.25

Table 4-8. AE Means by Years of Significant Athletic Experience, Rhythm Imitation Phase

Variable	Group	Mean	S.D.
AE6	0-4 years	53.39	36.61
	5-8 years	41.71	32.61
	9+	29.95	22.63
AE7	0-4 years	57.43	37.03
	5-8 years	47.93	39.67
	9+	43.33	34.40

Table 4.8. Continued

Variable	Group	Mean	S.D.
AE8	0-4 years	30.57	26.76
	5-8 years	31.46	21.38
	9+	31.67	25.20
AE9	0-4 years	45.90	37.61
	5-8 years	30.29	17.65
	9+	37.29	26.47
AE10	0-4 years	84.94	86.78
	5-8 years	59.79	62.68
	9+	42.86	33.95
AE11	0-4 years	65.29	55.24
	5-8 years	59.54	47.80
	9+	46.76	23.24
AE12	0-4 years	55.29	28.18
	5-8 years	43.04	29.54
	9+	39.95	24.43
AE13	0-4 years	57.82	36.52
	5-8 years	50.07	28.91
	9+	54.33	29.60
AE14	0-4 years	116.18	97.56
	5-8 years	99.89	62.27
	9+	111.48	122.59
AE15	0-4 years	74.67	64.67
	5-8 years	60.79	53.86
	9+	63.81	60.55
AE16	0-4 years	44.73	41.51
	5-8 years	37.14	34.33
	9+	34.24	35.80
AE17	0-4 years	54.47	45.90
	5-8 years	40.11	33.60
	9+	51.57	61.52
AE18	0-4 years	21.59	23.41
	5-8 years	23.68	26.63
	9+	33.67	27.82
AE19	0-4 years	26.12	29.13
	5-8 years	38.86	37.65
	9+	23.29	22.56
AE20	0-4 years	64.80	46.64
	5-8 years	56.68	48.38
	9+	53.48	34.73
AE21	0-4 years	30.16	48.30
	5-8 years	34.04	41.70
	9+	15.95	31.53

Table 4.8. Continued

Variable	Group	Mean	S.D.
AE22	0-4 years	49.43	61.96
	5-8 years	32.82	31.01
	9+	34.48	38.39
AE23	0-4 years	22.39	43.46
	5-8 years	23.14	43.47
	9+	31.67	51.45
AE24	0-4 years	31.25	41.65
	5-8 years	40.79	44.68
	9+	17.81	32.07
AE25	0-4 years	43.14	47.49
	5-8 years	57.21	50.54
	9+	42.43	51.97
AE6-25	0-4 years	51.53	23.30
	5-8 years	45.36	15.59
	9+	44.10	16.84

Table 4-9. AE Means by Years of Experience in Formal Music Training, Tapping Phase

Variable	Group	Mean	S.D.
AE1	0-4 years	57.37	56.98
	5-8 years	60.00	133.22
	9+	25.53	12.27
AE2	0-4 years	58.26	59.78
	5-8 years	35.63	28.34
	9+	24.58	10.11
AE3	0-4 years	43.97	38.93
	5-8 years	30.63	13.12
	9+	24.05	13.09
AE4	0-4 years	41.34	31.85
	5-8 years	34.89	21.26
	9+	19.63	8.49
AE5	0-4 years	36.39	37.73
	5-8 years	25.05	9.59
	9+	22.11	12.53
AE1-5	0-4 years	48.23	34.61
	5-8 years	37.21	33.18
	9+	24.44	6.25

Table 4-10. AE Means by Years of Experience in Formal Music Training, Rhythm Imitation Phase

Variable	Group	Mean	S.D.
AE6	0-4 years	50.66	38.35
	5-8 years	41.42	26.77
	9+	31.16	18.47
AE7	0-4 years	55.58	40.63
	5-8 years	52.42	33.28
	9+	38.89	27.44
AE8	0-4 years	35.35	27.80
	5-8 years	24.68	19.01
	9+	23.37	15.26
AE9	0-4 years	43.10	36.92
	5-8 years	38.21	21.04
	9+	30.21	15.12
AE10	0-4 years	72.73	63.63
	5-8 years	66.21	68.36
	9+	59.95	105.85
AE11	0-4 years	67.40	52.58
	5-8 years	57.95	45.87
	9+	36.79	23.51
AE12	0-4 years	51.39	29.25
	5-8 years	46.00	29.22
	9+	42.74	24.78
AE13	0-4 years	60.31	32.79
	5-8 years	49.89	35.27
	9+	42.37	28.49
AE14	0-4 years	138.58	107.07
	5-8 years	74.84	46.51
	9+	55.21	30.37
AE15	0-4 years	78.73	65.13
	5-8 years	56.47	55.77
	9+	47.16	42.26
AE16	0-4 years	42.89	41.56
	5-8 years	36.05	40.81
	9+	36.63	22.74
AE17	0-4 years	53.63	46.03
	5-8 years	36.79	56.32
	9+	50.53	37.16
AE18	0-4 years	24.27	27.40
	5-8 years	20.47	19.72
	9+	30.37	24.12
AE19	0-4 years	25.85	29.11
	5-8 years	36.37	39.21
	9+	32.37	27.34

Table 4.10. Continued

Variable	Group	Mean	S.D.
AE20	0-4 years	65.35	48.74
	5-8 years	59.42	45.39
	9+	43.89	23.30
AE21	0-4 years	28.81	47.30
	5-8 years	28.47	45.32
	9+	26.26	28.15
AE22	0-4 years	45.10	53.95
	5-8 years	55.68	55.32
	9+	16.32	15.70
AE23	0-4 years	22.42	46.50
	5-8 years	28.21	47.01
	9+	27.84	38.98
AE24	0-4 years	40.66	44.64
	5-8 years	22.00	31.89
	9+	9.00	24.93
AE25	0-4 years	47.37	51.67
	5-8 years	54.79	48.79
	9+	37.63	41.74
AE6-25	0-4 years	52.47	21.00
	5-8 years	44.47	19.17
	9+	37.89	14.16

CHAPTER 5
DISCUSSION

The purpose of this study was to investigate the influence of formal music training and significant athletic experience on rhythmic (temporal) perception. Rhythmic perception is one component of the group of kinesthetic perception. Also included in this group are vestibular, spatial, body, and directional awareness (perception). Vestibular and spatial awareness have been researched extensively in research in older individuals and those who participate in athletics (Gauchard, Jeandel, & Perrin, 2001; Golomer and Dupui, 2000; Lejeune et al., 2004; Bringoux et al., 2000). In addition, rhythmic perception has been studied in the music realm, focusing mostly on small children (Sievers, 1932; Williams, 1993; Volman and Geuze, 1998; Semjen, Vorberg, and Schultze, 1997; Fitzpatrick, Schmidt, and Lockman, 1996). For this investigation, several hypotheses were presented. In this section, those hypotheses and the results of the statistical tests will be discussed.

Discussion of Results

The first hypothesis presented in this paper was that individuals with experience in formal music training would have better rhythmic perception than those without formal music training. When comparing the two groups, post-hoc analysis of the MANOVA procedure indicated that in several areas those with formal music training had better rhythmic perception. Specifically, those with formal music training performed better on tests of tapping at 110bpm, 120bpm, 130bpm, 140bpm, and 150bpm. In addition, individuals with formal music training performed better on tests of rhythm imitation in

2/4 meter at 90bpm. When mean AE scores were combined by testing phase, those with formal music training performed better at tapping to a steady beat, imitating rhythms, and on the test as a whole. One possible explanation for this difference is that rhythm is a constant fixture in music and is the basis for all performance. In addition, those with formal music training played in marching band for at least 5 years, which combines the rhythm in music with the rhythm of walking (often within a group of 100 people or more).

Also included in the first hypothesis presented was that individuals with significant athletic experience would have better rhythmic perception than individuals without significant athletic experience. When comparing the two participant groups, post-hoc analysis of the MANOVA procedure indicated that individuals with significant athletic experience have better rhythmic perception than individuals without significant athletic experience. Specifically, those with significant athletic experience performed better on tests of tapping at 120bpm, 130bpm, 140bpm, and 150bpm. Individuals with significant athletic experience also performed better on tests of rhythm imitation in 2/4 meter at 90bpm. When mean AE scores were combined by testing phase, those with significant athletic experience performed better at tapping to a steady beat and on the test as a whole. This finding was interesting because most rhythm in sport experience is steady beat rather than imitation of specific rhythms. This is especially the case in gymnastics and pole vaulting, when an athlete uses an internal timing to complete movement successfully.

The first hypothesis presented in this paper also stated that the individuals with both significant athletic experience and formal music training would have better rhythmic perception than individuals without formal music training and significant athletic experience. According to post-hoc tests of the MANOVA procedure, this hypothesis was correct. Specifically, the MS group scored significantly lower AE means on tests of tapping at 120bpm, 130bpm, 140bpm, and 150bpm. In addition, the MS group scored significantly lower on tests of rhythm imitation in 2/4 meter at 90bpm when compared with the NMNS group. Furthermore, in 2/4 meter at 130bpm the MS group scored significantly better when compared with the NMS group. Rhythmic perception, as measured in the RPT-R, indicated that individuals with both formal music training and significant athletic experience scored better than all other groups, which may be a sign that music and sport experience is essential in the development of successful movement.

With regards to type of instrument, it was hypothesized that individuals who play a percussion instrument would have better rhythmic perception than those who play a woodwind or brass instrument. The ANOVA procedure did not reveal any significant differences between woodwind, brass, and percussion instrumentalists for mean AE scores. The data suggests that instrument type is not a factor in rhythmic perception. The researcher believes this might be due to the low number of percussionists participating in this study (n=6) when compared to woodwind (n=28) and brass (n=12) instrumentalists.

With regards to type of sport, it was hypothesized that those who play individual sports would have better rhythmic perception than those who play team sports, due the the more rhythmic nature of such sports as gymnastics and pole vaulting. The T-test procedure did reveal significant differences between these two groups, specifically in the combined tapping phase AE scores and imitating rhythms in 2/4 meter at 90bpm. These differences indicate that the hypothesis was partially incorrect. Participants involved in team sports performed significantly better in the tapping phase of the RPT-R, while the participants involved in individual sports performed significantly better in the rhythm imitation in 2/4 meter at 90bpm. One possible explanation for this is the need for those involved in team sports to be able to keep time with teammates in specific game situations, such as setting up a play in football. It is the conclusion of the researcher that regardless of sport type, rhythmic perception as a whole (tapping and rhythm imitation) yields no differences between groups, suggesting that involvement in any sport could indicate better rhythmic perception.

Another hypothesis presented in this paper was that years of experience in formal music training and significant athletic experience have an effect on performance. To test this, one-way ANOVAs were carried out separately for years of significant athletic experience and years of experience in formal music training. For significant athletic experience, the number of years of experience ranged from 0-17, for experience in formal music training, the number of years of experience ranged from 0-16. To decrease confusion among the years of experience variable, a frequency table and histogram were utilized to combine individuals into three groups: those with 0-4 years of experience, those with 5-8 years of experience, and those with 9+ years of experience.

The post-hoc analysis of the ANOVA procedure investigating years of significant athletic experience yielded significant differences in several areas between those with 0-4 years of experience and those with 9+ years of experience in several areas. Included in these areas are tapping to a steady beat at 120bpm, 130bpm, 140bpm, and 150bpm, and imitating rhythm in 2/4 meter at 90bpm. The post-hoc analysis also revealed differences between the group with 0-4 years of experience and the group with 5-8 years of experience in tapping at 140bpm and on the tapping section as a whole. Based on this data, it can be concluded that more years of significant athletic experience may indicate better rhythmic perception.

The post-hoc analysis of the ANOVA procedure investigating years of experience in formal music training also yielded significant differences between those with 0-4 years of experience and those with 9+ years of experience in tapping at 120bpm, 130bpm, 140bpm, imitating rhythm in 2/4 meter at 130bpm, imitating rhythm in 2/4 meter at 90bpm, the tapping phase, the rhythm imitation phase, and on the entire test as a whole. In addition, post-hoc analysis found significant differences between those with 0-4 years of experience and those with 5-8 years of experience, as well as between those with 5-8 years of experience and those with 9+ years of experience, for imitating rhythm in 2/4 meter at 90bpm. It can be concluded from this information that the individuals with more experience in formal music training have better rhythmic perception.

Relationship to Multiple Intelligence Theory and Arts and Brain Development

Within the constructs of Multiple Intelligence theory, intelligence has both biological and cultural entities and, as described by Gardner (1999), intelligence is “a biophysical potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture” (p.33-34). In this sense, individuals are born with all seven intelligences, and the extent to which each intelligence is expressed is determined by the culture that surrounds the individual. With this information, it can be assumed that the participants in this study could have been influenced by their culture to exhibit bodily-kinesthetic and musical intelligences through rhythm. As per the results of the RPT-R, those individuals with a bodily kinesthetic intelligence (specifically, the MS and NMS groups) or musical intelligence (specifically, the MS and MNS groups) performed better than the group of individuals with no experience in formal music training or significant athletic experience possibly because they were exposed to these entities through their culture. In addition, the time involved in the exposure to music or movement activities had a great effect on individual rhythmic perception among the participants in this sample. This indicates that it may not just be the type, but also the amount, of exposure that may determine how successful individuals will be with regards to rhythmic perception.

It must be reiterated that the weak interpretation of the MI theory was used as a framework in this particular study, as participants were not given any formal measure to determine which intelligences were more pronounced. As indicated in the literature, the weak interpretation states that all intelligences work in conjunction (Klein, 1997). As such, it is difficult for any measure of MI theory constructs to be separated and defined individually.

The musical and kinesthetic arts, as related to the musical and bodily-kinesthetic intelligences, are important in developing certain components of kinesthetic perception, especially vestibular and spatial awareness. Since rhythmic awareness is another component, it can be determined from this study that having training in rhythm through the musical or kinesthetic arts may be another contributor to overall improvement of kinesthetic awareness. This can be seen through the overall performance on the RPT-R by participants who had both formal music training and significant athletic experience, as these individuals scored better on the RPT-R in several areas, not only basic steady beat interpretation.

Suggestions for Further Research and Concluding Remarks

Future research in this area should include investigations on a larger scale, in different populations, and in different areas of musical training. Since the definition of formal music training was limited to marching band students, it may be interesting to investigate rhythmic perception in individuals with experience in orchestra and chorus. Similarly, it may be beneficial to look at the rhythmic abilities of individuals who play different sports, more specific than team or individual sports. Each sport requires a different amount and type of rhythm, so looking at athletes in gymnastics, track and field, football, basketball, lacrosse, and other sports may lead to conclusions about which sports may influence rhythmic perception. From the perspective of remediation, specific interventions by age group should be investigated. As noted by Gauchard, Jeandel, and Perrin (2001), simple interventions to reactivate vestibular awareness were successful among the elderly. Perhaps the same result may be true of reactivating rhythmic perception in the elderly and even in younger age groups.

Another recommendation from this study is to investigate the relationship among rhythmic perception of students who were exposed to rhythmic activities in various physical education classes. It is general knowledge that lessons involving basic rhythm are used at the elementary level but disappear in the secondary schools. Even today, as engagement times become shorter for physical education and music classes, there is less time available to work on rhythmic perception. As the results of this study indicate, specific practice in these areas may contribute to better rhythmic perception, which reiterates the basic need for more time in physical education and music classes. Perhaps intervention studies could illustrate this finding more specifically.

From this investigation on the rhythmic perception of individuals with formal music training and significant athletic experience, it can be concluded that individuals with at least 5 years of experience have better rhythmic perception than those who have less than 5 years of experience. In this case, type of sport or musical instrument did not make a difference in rhythmic perception. As such, starting children in music or sport education at an early age and having them continue through puberty and early adulthood may contribute to more successful movement. Preferably, involvement in both areas may be useful in targeting the different areas of the brain, but involvement in at least one may increase rhythmic ability.

APPENDIX A
DEMOGRAPHIC SURVEY

Music and Movement: The Influence of Formal Music Training on Rhythmic Perception
Demographic Survey

What is your name?	
How old are you?	
What is your Race/Ethnicity? (please circle one)	Caucasian Hispanic Black Asian and Pacific Islander American Indian Other
What is your gender? (please circle one)	Male Female

Significant athletic participation *refers to 5 years or more participation in an organized sport at any combination of select, varsity, junior varsity, elite, or collegiate level athletics.*

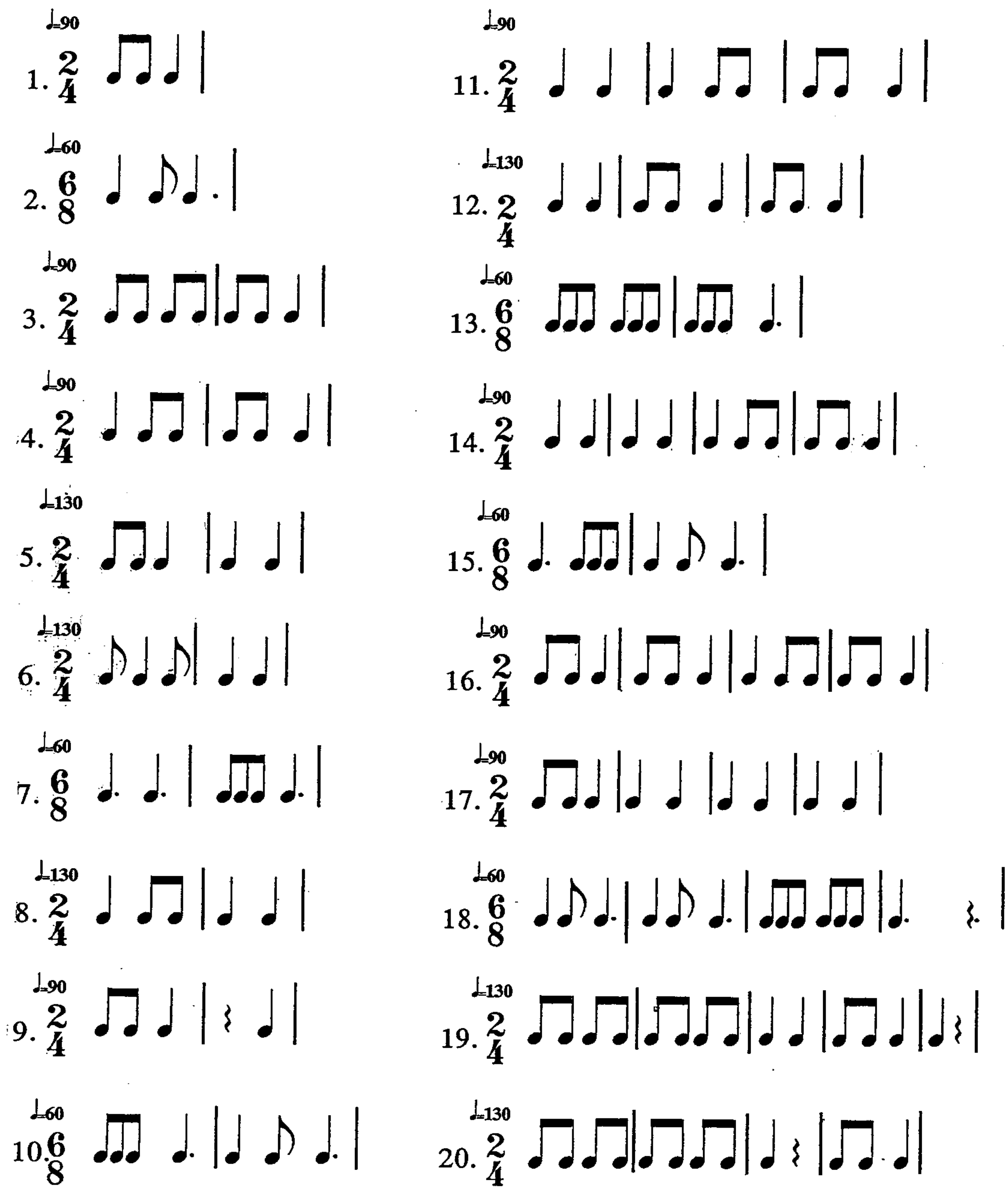
Given this definition, how many years have you participated in a significant athletic activity?	
What sport did you participate in at this level?	

Musically trained *refers to 5 years or more of music study on a band instrument (woodwind, brass, or percussion). Music study is limited to organized band classes or private lessons.*

Given this definition, how many years have you participated in formal music training?	
What type of instrument do you play? (please circle one)	Woodwind Brass Percussion

APPENDIX B

LIST OF RHYTHMS IN PART TWO OF THE RPT-R



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BIOGRAPHICAL SKETCH

Jody Crollick was born in Media, Pennsylvania, on July 28, 1981. She moved to Tampa, Florida, at the age of 6. Jody received her bachelor's degree from the University of Florida in exercise and sport sciences, athletic training specialization, in August, 2003. She began work on her master's degree in exercise and sport sciences, with a focus in exercise and sport pedagogy, in fall of 2003. Jody worked closely with Dr. David Fleming, Ph.D., and James Zhang, Ed.D., on the Florida 21st Century Community Learning Centers Evaluation Program grant, in which she was involved in data collection and analysis. After graduation, Jody plans to teach elementary or middle school physical education, and then pursue a Doctor of Philosophy degree in physical education teacher education. She hopes to become a college professor of physical education.