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Differences in Visual and Kinesthetic Imagery Abilities as Controlled by the Habitual Physical Activity of Middle and High School Students

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DIFFERENCES IN VISUAL AND KINESTHETIC IMAGERY ABILITIES AS CONTROLLED BY THE HABITUAL PHYSICAL ACTIVITY OF MIDDLE AND HIGH SCHOOL STUDENTS

BY

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To the Dean of the School of Human Performance and Leisure Sciences:

I am submitting herewith a thesis written by Candice M. Franco entitled "Differences in Visual and Kinesthetic Imagery Abilities as Controlled by the Habitual Physical Activity of Middle and High School Students." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science with a major in Movement Science.

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Gualberto Cremades, Thesis Committee Chair

We, members of the thesis committee,
have examined this thesis
and recommend its acceptance:

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Accepted:

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Chair, Department of Sport and Exercise Sciences

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ABSTRACT

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The purpose of this study was to investigate age differences in the visual and kinesthetic imagery abilities of middle (n = 93) and high school (n = 99) students as well as to examine the potential influence of habitual physical activity in school, sport and during leisure time on both of these imagery abilities. The participants completed two questionnaires: the MIQ-R (Hall & Martin, 1997) and the BQHPA (Baecke, Burema & Fritjers, 1982). The results of this study were analyzed using a 2x2 (age by imagery ability) mixed model ANCOVA with the three subscales of habitual physical activity (physical activity at school, participation in sports, physical activity during free time) as covariates. Middle school students did not exhibit significant differences in visual and kinesthetic imagery abilities and the high school students did not exhibit significant differences in these imagery abilities either. The age group x imagery ability interaction ($F(1,188) = 1.689$, $p > .05$, $\eta^2_p = .009$) was not significant. High school students did not exhibit higher imagery abilities than middle school students, therefore the main effect for age group ($F(1,188) = .018$, $p > .05$, $\eta^2_p = .000$) was not significant. The Cronbach's alpha level of the BQHPA physical activity at school subscale was .157, therefore this hypothesis was not tested due to the subscale's lack of reliability. The Imagery Ability x Habitual Physical Activity in Sport interaction ($F(1,188) = 3.451$, p = .065, $\eta^2_p = .018$) was approaching significance, however there was not a significant interaction of imagery type by physical activity during leisure time ($F(1,188) = 1.689$, p>.05, $\eta^2_p = .009$). The results of this study indicate that there are no differences in the visual and kinesthetic imagery abilities within the middle and high school age groups, nor were there significant differences between these two age groups. Furthermore, a trend may exist for the participants with high levels of physical activity in sport as they may exhibit greater visual and kinesthetic imagery abilities then their peers with low habitual physical activity in sport. Lastly, it is recommended that an alternative instrument be created which assesses the visual and kinesthetic imagery abilities of children.

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CHAPTER 1

Introduction

Imagery involves the mental creation or recreation of an experience which incorporates all of the senses. Athletes use mental imagery to attain their goals and improve performance. Paivio (1985) identified two functions of imagery: cognitive and motivational. The cognitive function of imagery provides the athlete with the opportunity to rehearse sport skills and plan strategies before a competition while the motivational aspect makes it possible to experience goal attainment, practice coping and manage one's arousal. Within these two functions, five specific dimensions have been identified: motivational-specific, motivational general-mastery, motivational general-arousal, cognitive specific and cognitive general (Hall, Mack, Paivio, & Hausenblas, 1998).

The effectiveness of imagery has been examined thoroughly in adult athletes with evidence indicating that the use of imagery is facilitative for athletic performance (Vandall, Davis, & Clugston, 1934; Corbin, 1972; Shelton & Mahoney, 1978; Murphy & Jowdy, 1992; Doheny, 1993; Martin, Moritz, & Hall, 1999) and emotional response (Garza & Feltz, 1998; Martin & Hall, 1995; Cogan & Petrie, 1995). Elite athletes have reported using imagery consistently and systematically with success (Orlick & Partington, 1988; Smith, 1987; Hall & Rodgers, 1989). Two categories of imagery which are frequently used by athletes include visual and kinesthetic imagery; however a disproportionately greater body of research is focused on visual imagery ability than kinesthetic imagery ability.

Research such as this has also been carried out with children so as to investigate the development of visual and kinesthetic imagery by examining age differences in imagery abilities (Kosslyn, Margolis, Barrett, Goldknopf, & Daly, 1990). In some studies basic instruction on the imagery type to be assessed (Livesey, 2002; Willoughby, Porter, Belsito, & Yearsley, 1999; Pressley & Levin, 1980; Brody, Mattson, & Zuckerwise, 1978;) or general prompts (Hoffman & Hawkins, 1980; Wolf & Levin, 1972; Youniss & De Shazo Robertson, 1970) were given by the researcher(s) to ensure that the participants created and used imagery as imagery ability was the variable measured. With minimal instruction provided in these studies the results describe developmental differences or similarities in imagery abilities as a function of age rather than improved performance as a function of imagery training.

Piaget, Inhelder and Szeminska (1960) theorized that in order for a child to visually manipulate an object, he/she must be able to link the movement to a series of reference points in space. Five levels were identified in the development of reference systems and the imaging of spatial movement (Levels I-V), which define visual imagery ability in children and illustrate greater ability with age. Other research is consistent with these findings (Dean, 1976; Wolff & Levin, 1972; Pressley & Levin, 1980). Recent research supports these developmental changes in which a relationship between visual movement imagery and kinesthesis appears to develop between the ages of 10 and 14 (Livesey, 2002). Contrary to these findings, results have demonstrated that 4-year-olds (Brody et al., 1978) and 5 and 6-year-olds (Ryan, Ledger & Weed, 1987) have been shown to exhibit visual imagery strategy if given extensive practice. Additional results conflict with the development of visual imagery ability as strictly related to age (Kosslyn et al., 1990; Borduin, Borduin, & Manley, 1993; Willoughby, et al., 1999). More information is needed to clarify this topic.

Several studies on visual imagery have been shown to benefit performance in memory tasks (Hollenberg, 1970; Hoffman & Hawkins, 1980) and spelling performance (Sears & Johnson, 2001) with children as the sample population. Additionally, higher visual imagery ability has been significantly correlated with creative thinking in children (González, Campos, & Pérez, 1997). Likewise, the use of visual imagery has also positively influenced retention scores (Bull & Wittrock, 1973). Paivio (1971) explained that visually imagery can facilitate retention because information is stored in an imaginal and verbal mode, and imagery makes it possible to elaborate verbal information into concrete imaginal information. Imagery also has facilitative effects on dance movement (Hanrahan & Salmela, 1990) and postural correction for proper alignment in dance (Sweigard, 1974). As this information shows, imagery use in children can be beneficial in a variety of ways.

A different line of research points out the potential influence that physical activity has on imagery ability. For example, Ozel, Larue and Molinaro (2004) reported that athletes who participate in sport exhibit faster mental rotation of objects than nonathletes. In a different study, dance instructors with a mean performance experience of 17 years and mean teaching experience of 20 years report high visual and kinesthetic imagery abilities across varying tasks (Overby, 1990). More information is needed regarding the potential influence that physical activity may have on children’s imagery ability. Furthermore, the majority of the information available on the development and use of imagery in children focuses on visual imagery ability, with sparse information on kinesthetic imagery use and ability in children or adolescents (Ille & Cadopi, 1999).

Statement of the Problem

According to existing research, visual imagery has a beneficial effect on performance, learning and memory in children. However, the development of visual imagery ability is not well understood as conflicting reports exist. Furthermore, a disproportionately larger body of research focuses on visual imagery ability as a facilitator of performance, learning and memory than kinesthetic imagery ability. More information is needed to better understand the development of both imagery abilities and to fill the gap in literature regarding children's kinesthetic imagery ability. One of the potential factors which may influence imagery ability is physical activity; however this has not been adequately addressed in the literature either. The primary goal of this study was to explore developmental differences in visual and kinesthetic imagery abilities and the influence physical activity may have on imagery ability development in children.

Purpose of the Study

The purpose of the study was to investigate differences in the development of visual and kinesthetic imagery abilities by comparing these abilities in middle school age and high school age children. This was accomplished by examining differences between middle and high school students as measured by visual imagery ability and kinesthetic imagery ability. This study also examined whether physical activity has an influence on visual and kinesthetic imagery abilities at these ages.

Hypotheses

- Middle school students will exhibit greater visual imagery ability than
- kinesthetic imagery ability while controlling for habitual physical activity.
- There will be no difference in visual and kinesthetic imagery abilities for high school students while controlling for habitual physical activity.
- High school students will exhibit greater visual and kinesthetic imagery abilities than middle school students while controlling for habitual physical activity.
- Students with higher physical activity at school will exhibit greater imagery abilities than student with lower habitual physical activity at school.
- Students with higher participation in sport will exhibit greater imagery abilities than students with lower participation in sport.
- Students with greater physical activity during their leisure time will exhibit greater imagery abilities with lower habitual physical activity during their leisure time.

Significance of the Study

Visual and kinesthetic imagery abilities have been used to enhance athletic performance in adults and to positively influence learning (Feltz & Landers, 1983; Hardy & Callow, 1999). The development of visual imagery ability has been investigated with consistent results such that by sixth grade visual imagery ability can be used to improve performance (Pressley & Levin, 1980; Isaac & Marks, 1994, p. 495). However, there is a gap in the research on the development of visual imagery ability beyond this middle school stage.

Furthermore, there is no research comparing the kinesthetic imagery abilities in middle and high school age students. Because both categories of imagery ability can be used to enhance learning and performance, it is important to investigate the development of both types of imagery ability at middle and high school age. This will help educators and coaches recognize when implementation of these strategies is appropriate and beneficial. Additionally, investigators who have mentally trained children to use imagery strategies report that it is advantageous for elementary school children to have experience in several strategies of learning and athletic performance (Orlick & McCaffrey, 1991). Given that younger children benefit from multiple strategies for success, middle and high school age children are likely to benefit as well.

Lastly, physical activity has been shown to influence imagery abilities in adult athletes (Ozel et al., 2004), yet this topic has not been addressed with children as the sample population. The American Heart Association reports that children spend an average of three to four hours a day watching TV and are lacking in habitual physical activity. It is necessary to investigate the influence this may have on children's imagery abilities which have been shown to benefit retention (Bull & Wittrock, 1973), memory (Hollenberg, 1970; Hoffman & Hawkins, 1980) and physical performance (Calopi & d'Arripe-Longueville, 1998; Feltz & Landers, 1983; Hall, 1985).

Delimitations

In the present study participants were middle school students (ages 11-13) and high school students (ages 15-17) whose parents gave permission for their participation. Nearly 75% of the participants were of middle economic status as they were enrolled in a public charter school in south Florida which gives preference to residents of a small community within a major city. Approximately 147 students out of the 525 enrolled at this school during the study were enrolled in the National School Lunch Program during which is a federally funded program offering assistance to families in need. In order to qualify for free meals, the family income must be at or below 130% of the poverty level while students eligible for reduced meals have family incomes between 130 – 185% of the poverty level.

Limitations

The students arrived at school by 7:45 a.m.; however the number of hours they slept and whether or not they ate breakfast that morning were variable and may have influenced their ability to complete the questionnaires accurately. Furthermore, the participants must have understood the instructions in order to complete the questionnaires correctly. Identical instructions were read to each participant prior to beginning each questionnaire and these instructions were also posted on each questionnaire in case the participants needed to reference them. Because self-reports were used to collect data, a limitation of this study was be the participants' willingness to answer honestly.

Assumptions

It was assumed that the learning differences and/or disabilities of students enrolled at the charter school have been documented and reported to the appropriate administrators within the school system. Data collected from students exhibiting such variations was not included in data analysis.

Operational Definitions

Visual imagery ability: the ease with which a participant can visualize oneself performing a specified movement from either an internal or external perspective.

Kinesthetic imagery ability: the ease with which a participant can feel oneself performing a specified movement from an internal perspective.

Middle school student: males and females between 11-13 years of age who are enrolled in sixth or seventh grade when completing the questionnaires.

High school students: males and females between 15 – 17 years who are enrolled in tenth or eleventh grade when completing the questionnaires.

Habitual physical activity: engagement in at least three 30 minute segments of physical activity per week such as running, jogging, biking, skateboarding, playing a sport, swimming, sailing, etc.

Development: changes that occur in the ability to create motor imagery as a function of age.

CHAPTER 2

Review of Literature

Imagery is a technique in which the senses are used to mentally rehearse an experience. This is possible because imagery incorporates information stored in the memory, thus allowing an individual to assess a past performance and identify strengths and weaknesses. Imagery can also be used to simulate new experiences as a method of preparing oneself for performance in an unfamiliar context such as an international competition. Creating familiarity with this new context can be achieved by the use of imagery as research indicates that the brain interprets imagery identically to actual external stimuli (Marks, 1983; Fisher, 1986). However, no external stimuli are required for imagery use as it is a mental task which occurs without environmental feedback, cues or props.

Though imagery is often referred to as visualization, it is important to recognize that imagery can be a polysensory experience which incorporates multiple senses at the same time. Vealey and Greenleaf (2001, p. 248) defined imagery as “using all the senses to re-create or create an experience in the mind.” Auditory, olfactory, tactile and gustatory senses can be incorporated in the creation or recreation of an experience, however the visual and kinesthetic senses are the most widely researched for performance enhancement purposes. Visual imagery incorporates the stimuli seen during a performance. Kinesthetic imagery incorporates the feel of a movement and the sensations felt by the body as it moves. Hall, Rodgers, and Barr (1990) reported that athletes from six different sports use visual and kinesthetic imagery in conjunction with competitive situations more so than with practice and that greater frequency of imagery use is reported with higher levels of competition.

This study investigates the visual and kinesthetic imagery abilities of middle and high school children. This was achieved by using self-report measures which allowed the participants to analyze and rate the ease with which they image visually and kinesthetically. The intent of this literature review is to provide a foundation of previous research on the theoretical explanations of how imagery operates, the cognitive and motivational functions it has for athletes, the types of imagery most frequently used by athletes, and the development of imagery abilities. This study also investigates the habitual physical activity of middle and high school students in order to examine the potential affects this may have on their imagery abilities. A self-report measure analyzing the amount of physical activity the participants engage in during a typical day was completed. Thus, the final topic of this literature review summarizes research on imagery and physical activity.

Theoretical Explanations of How Imagery Influences Performance

Several theories have been developed which attempt to explain how imagery functions: psychoneuromuscular, symbolic learning, attention and set arousal and bioinformational. Psychoneuromuscular theory suggests that engaging in mental imagery creates subliminal neuromuscular patterns that mimic those which are created during actual movement or physical activity (Vealey & Greenleaf, 2001). According to this theory, imagery makes it possible for an individual to practice and improve a desired movement pattern without actually performing. This theory suggests that imagery enhances performance because messages are sent from the brain to the muscles during imagery which are similar to those that actually produce the movement. Vealey and Walter (1993) suggested that imagery use allows the muscles to fire in a sequence specific for the movement imaged even though the movement is not performed. Consequently, the brain is able to engage in a motor schema for a movement pattern.

Jacobson (1931) was the first to demonstrate this when contractions in the flexor muscle were created while bending of the arm was imaged. Other results show that increased cerebral blood flow (Ingvar & Philipson, 1977) and electrical activity in the muscles (Hale, 1982; Bird, 1984; Harris & Robinson, 1986; Jowdy & Harris, 1990; Williams, Rippon, Stone & Annett, 1995) occurs during mental imagery practice. This electrical activity is similar to the activity which occurs when a message is sent from the brain to the muscles. Suinn (1980) found similar results such that muscle innervation was observed in the participant who imaged a downhill skiing run. Suinn also concluded that increased electrical activity during certain portions of the mental task was associated with portions of the skiing run that would have required increased muscle recruitment. Lerner, Ostrow, Yura, & Etzel (1996) reported that in order for imagery to facilitate free-throw performance as explained by psychoneuromuscular theory, an athlete must have an adequate amount of time to engage in mental rehearsal repeatedly before facilitative affects can be observed. Research supports the psychoneuromuscular theory such that electrical activity occurring in a muscle is associated with mental imagery usage.

Another theory which addresses how imagery works to facilitate performance is the symbolic learning theory (Sackett, 1934; MacKay, 1981). According to this theory, imagery may help athletes understand a movement pattern because it functions as a coding system which allows the individual to plan an action in advance. Symbolic learning theory suggests that imagery helps to make a movement more familiar because all possible events and responses are sequenced and considered. Hall and Erffmeyer (1983) reported enhanced performance on free throw shooting when imagery was used to code components of the movement involved in this activity. Consequently, the desired execution of a movement can become an automatic response to stimuli which are anticipated during imagery use.

Symbolic learning theory suggests that great cognitive functioning occurs before a physical response is made. Research supporting this theory includes activities that are cognitive in nature rather than activities which are motor in nature (Feltz & Landers, 1983; Feltz, Landers, & Becker, 1988; Hird, Landers, Thomas, & Horan, 1991). According to this theory, rehearsing all possible situations can facilitate performance because an individual is more likely to respond successfully if he/she has imaged and coded all possible responses. Symbolic learning theory also predicts that experienced performers will benefit more from imagery because they may already have symbolic representation in place, therefore the use of imagery will strengthen this representation.

A different explanation of how imagery work is attention and arousal set theory. This theoretical postulate integrates the physiological aspects of the psychoneuro-muscular with the cognitive components of the symbolic learning theory. According to the attention and arousal set theory, the physiological component of imagery use entails controlling and sustaining an optimal state of arousal during a performance. Research supporting this theory included results which show that imagery facilitates reaching an optimal state of arousal during a performance (Hale & Whitehouse, 1998; Page, Sime, &

Nordell, 1999). The cognitive aspect of this theory suggests that maintaining this optimal state of arousal enables an individual to focus on a task or strategy, thus reducing the likelihood of distraction and poor performance.

A more recent theoretical explanation is Lang's (1979) bioinformational theory attempts to account for how imagery facilitates performance by assuming that an image has both stimulus and response prepositions. Stimulus prepositions incorporate environmental information, are unique to the individual, and may reflect the image's meaning for that person. Response prepositions are the behaviors, cognitions and feelings encompassed in an image. According to the bioinformational theory, the response prepositions associated with the stimulus can be targeted, improved and adjusted repeatedly (Lang, Melamed, & Hart, 1970). The imaged responses will represent the individual's desired performance despite potentially interfering physical and emotional feelings, thus making it more likely for an individual to execute a desired response in similar situations.

This theory is supported by research which incorporates physiological activity. Bakker, Boschker & Chung (1996) concluded that response-oriented imagery results in greater physiological activity than stimulus-oriented imagery. Similarly, Hale (1982) reported higher EMG activity when an internal perspective (i.e. response prepositions) is used rather than an external perspective (i.e. stimulus prepositions). Moreover, Feltz and Landers (1983) reported that expert athletes benefit more from imagery use than novice athletes. According to the bioinformational theory, this may be due to the fact that expert athletes have more experiences (which include both stimulus and response prepositions) to draw upon during mental imagery rehearsal than inexperienced athletes. This theory originally addressed the effectiveness of imagery in patients with anxiety disorders; however, research indicates that this theory may also explain the effectiveness of imagery used by athletes as a method of performance enhancement.

To summarize, the psychoneuromuscular, symbolic learning, attention and set arousal and bioinformational theories present explanations for how imagery functions. Psychoneuromuscular theory is based upon physiological evidence suggesting that imagery is strongly linked to muscle innervation which is due to messages sent from the brain to the muscles while imaging a movement. This activity may enhance the likelihood that a desired movement is performed when needed. Alternately, symbolic learning theory suggests that a movement is more likely to be correctly executed when it is familiar to an athlete. According to this theory, imaging a movement makes it more familiar and allows an athlete to plan it in advance. Attention set arousal theory puts the physiological elements of the psychoneuromuscular theory and cognitive elements of the symbolic learning theory together in an explanation which posits that an athlete must sustain an optimal state of arousal to execute movement and focus on the task at hand. Lastly, bioinformational theory identifies stimulus propositions (environmental information) and response propositions (behaviors, thoughts, and feelings) as key components to imagery processing and further asserts that imagery allows an athlete to target and rehearse desired responses which makes these responses more likely to occur when needed.

Because these theories have physiological components, much of the research investigating how imagery works has examined physiological responses (Jacobson, 1931; Hale, 1982; Bird, 1984; Harris & Robinson, 1986; Jowdy & Harris, 1990; Williams et al., 1995; Hale & Whitehouse, 1998; Page, Sime, & Nordell, 1999). Of this research, Hale (1982) and Harris and Robinson (1986) reported that greater physiological response is observed when athletes image in specific ways. Given these results, performance may be better facilitated when specific types of imagery are used (Hall, Schmidt, Durand, & Buckolz, 1994). For example, it may benefit an athlete to use imagery which has been shown to evoke physiological responses if the athlete's goal is to achieve enhanced motor control or behavior. Furthermore, Feltz and Landers (1983) reported that expert novice athletes benefit from imagery use but that it is the experts which benefit the most. Therefore, coaches of elite athletes may find it helpful to incorporate imagery training as a major component to athletic preparation. Thus, research investigating the theoretical explanations of how imagery works presents implications for how imagery can and should be used in order to achieve maximal results in an applied setting.

Functions of Imagery

Visual and kinesthetic imagery are of primary interest to coaches and athletes as a means of enhancing performance. Consequently, imagery has been used as a tool to enhance performance in several ways. The two functions of visual and kinesthetic imagery which are identified according to Paivio's Two-Dimensional Model (1985) are cognitive and motivational. According to this model, visual and kinesthetic imagery influences the cognitive and motivation response systems which subsequently influence motor behavior. Hall et al. (1998) revised this model by identifying components within the cognitive and motivational functions and further classifying them. The first function, cognitive imagery, incorporates visual or kinesthetic rehearsal of specific skills and strategies of performance. This is often used before a competition. This function was subdivided by Hall et al. (1998) into cognitive specific imagery, wherein an individual rehearses the execution of a particular movement or task during a competition. The other subcategory identified is cognitive general imagery where an individual rehearses a strategy such as running a play.

According to Paivio's (1985) model, the second function of visual and kinesthetic imagery is motivational. Hall et al. (1998) further divided this dimension into three categories. Motivational specific imagery involves visually or kinesthetically rehearsing a situation that is highly motivating and experiencing the emotions that result from achieving a goal such as making a game-winning shot. The motivational general-arousal subcategory allows an individual to focus on controlling one's anxiety in a general sport situation such as going up to bat or kicking a field goal. The last subcategory of motivational imagery function is motivational general-mastery which involves imagining oneself maintaining or regaining focus, such as after making a mistake. In the following subsection, both functions (i.e., cognitive and motivational) will be discussed in detail.

Cognitive Function

Cognitive specific imagery incorporates visual cues and kinesthetic sensations to help an athlete rehearse and master targeted skills. For example, a tennis player who images the form and feel of a perfect serve could use cognitive specific imagery to visually and kinesthetically rehearse this skill. Research indicates that using cognitive specific imagery facilitates learning and improves performance (Beauchamp, Halliwell, Fournier, & Koester, 1996; McKenzie & Howe, 1997; Driskel, Copper, & Moran, 1994; Lee, 1990; Burhans, Richman, & Bergey, 1988; Feltz & Landers, 1983). Hall et al. (1998) identified and described the cognitive specific function as an elaboration of Paivio's (1985) model; however Munroe, Giacobbi, Hall, and Weinberg (2000) suggested that there are two aspects to cognitive specific imagery which still must be recognized: technique and correction. The authors argued that the technical aspect should be emphasized if an athlete seeks to become more consistent in performing successfully while the correctional aspect should be emphasized for an athlete seeking to correct a bad habit.

In a specific study, Beauchamp, Halliwell, Fourneir, and Koestner (2002) reported that golfers who also used pre-competition cognitive specific imagery showed improved performance. Other research reports improved performance for dart throwing (McKenzie & Howe, 1997; Straub, 1989) and free throw shooting (Wrisberg & Anshel, 1989) with imagery use as well. In a later study investigating improvement strategies for free-throw shooting and grip strength tasks, results indicate that visual and kinesthetic cognitive specific imagery improved the athletes' performance in free-throw shooting but did not have an affect on the athletes' grip strength (Peynircioğlu, Thompson, & Tanielian, 2000). The authors suggested that cognitive specific imagery may enhance performance of activities which have cognitive components such as free-throw shooting but may not enhance performances of tasks that are primarily gross motor skills. These results indicate that imagery can be used to rehearse skills and enhance performance.

Cognitive general imagery involves the rehearsal of strategies, plays and routines. While these are significant components to successful performance in sport, Martin et al.

(1999) noted that cognitive general imagery has not been investigated as thoroughly as cognitive specific imagery. Case studies have documented enhanced performance with the use of cognitive general imagery for football plays (Fenker & Labmiotte, 1987) and wrestling (Rushall, 1988). Garza and Feltz (1998) investigated the performance of female figure skaters who underwent four weeks of intervention training. During the intervention, one group of skaters was instructed to visually and kinesthetically image each component of her routine to the best of her ability. The imagery rehearsal lasted the same duration as the routine and all skaters were instructed to perform this imagery exercise once each day throughout the intervention period. Prior to performing in an annual competition which was held at the completion of training, each skater imaged her routine before performing it. Upon analysis of their performances, a significant treatment effect was observed for the skaters who used cognitive general imagery. Similar results exist for another group of skaters' long programs (Madigan, Frey, & Matlock, 1992) gymnastic routines (White & Hardy, 1998; Mace, Eastman, & Carroll, 1987) and slalom canoests (White & Hardy, 1998). Given that cognitive general imagery involves the rehearsal of strategy and that strategies develop as a competitive season progresses, research indicates that athletes who participant in team sports use increasing amounts of cognitive general imagery as the season progresses (Munroe, Hall, Simms, & Weinberg, 1998). This is further evidence that cognitive general imagery can enhance performance.

Motivational Function

Athletes can utilize visual and kinesthetic imagery for a variety of purposes. One of the areas that athletes target for improvement is self-confidence because it is recognized as a key component in successful performance. Vealey (1986) identified trait and state sport confidence as characteristics which are important for athletes and their performance. Recent research concludes that individuals participating in tae kwon-do who have high self-confidence perform more successfully than those who do not exhibit high levels of self-confidence (Chapman, Lane, Brierley, & Terry, 1997). The same results are supported for athletes in various sports such that self-confidence can be used as a predictor in fine motor anaerobic and gross motor aerobic sports (Taylor, 1987). Given that self-confidence has been shown to improve and predict athletic performance, strategies for improving self-confidence have been explored. One such strategy includes the use of visual and kinesthetic imagery.

In order for visual and kinesthetic imagery to be used as a method of improving confidence in athletes it is important to assess imagery content according to Paivio's (1985) model. Illustrating the effects of imagery content on confidence, Hale and Whitehouse (1998) presented elite soccer players with video clips of familiar game situations (cognitive) and flashed one of two words on the screen as they viewed the clips (motivational). For one of the groups the word "challenge" was flashed on the screen during these competitive situations and for the others the word "pressure" was flashed on the screen during the clips of critical game situations. The athletes who viewed the images while a positive word was presented reported higher confidence than the second group of athletes though both viewed the same game situations. Martin et al. (1999) suggested that in order for imagery use to effectively enhance confidence, one must engage in motivational imagery which focuses on this emotional goal instead of cognitive imagery which is designed to support the mastery of physical skills needed during a successful performance.

Suinn (1996) described visual motivational imagery as seeing oneself winning or performing in a confident manner repeatedly. Research indicates that visual imagery which is used for motivational purposes has a greater effect on confidence than visual imagery which is used for cognitive purposes (Callow, Hardy, & Hall, 1998; Callow & Hardy, 2001). A six week intervention examining the effects of visual imagery on confidence in 3 elite badminton players improved the confidence of two players and stabilized the third player's confidence level (Callow et al., 1998). Visual motivational imagery appears to positively influence player confidence.

The research available on imagery and confidence predominantly investigates the effects of visual imagery. In an attempt to fill the gap in literature on kinesthetic imagery, Callow and Waters (2005) directly tested kinesthetic imagery on the confidence levels of three flat-race horse jockeys. A significant increase in sport confidence was observed for two of these athletes. Another investigation of trait sport confidence in 111 track and field athletes examined the frequency of both visual and kinesthetic imagery use by high and low confidence athletes as well as the types of imagery most frequently by each group (Abma, Fry, Li, & Relyea, 2002). Results indicate that high confidence athletes use imagery with higher frequency than low confidence athletes and both groups of athletes use motivational general mastery more frequently than any other type of motivational or cognitive imagery. No significant differences were reported for visual or kinesthetic imagery abilities in high and low confidence athletes; however the authors conclude that high confidence athletes use both visual and kinesthetic imagery with greater frequency than low confidence athletes. Based on the literature available it can be concluded that motivational imagery has a greater influence on athlete's confidence than cognitive imagery and that both visual and kinesthetic motivational imagery can be used to reach these results.

Imagery has also been shown to help athletes achieve optimal levels of arousal. In order to use imagery in this way, athletes must determine at what level of arousal they perform well. Identifying this state of arousal can be achieved with self-awareness training. Athletes who need to increase their levels of arousal prior to a performance can image playing intensely and/or aggressively. Research shows that imagery has an influence on physiological responses such breathing and heart rate (Gallego, Denot-Ledunois, Vardon, & Perruchet, 1996). Competitive swimmers were asked to visually image a series of scenes which brought them closer to the starting position assumed prior to the start of a race. For all participants, the breathing rate and heart rate increased as the series of images progressed toward the imaged start of a race. This visual imagery exercise would be considered motivational general-mastery which, according to existing research, is a type of imagery is frequently used by athletes to increase their arousal to an optimal level (White & Hardy, 1998).

Athletes can also use visual and kinesthetic imagery to lower arousal. For example, it would be helpful for an athlete to master a method of lowering arousal in a situation of intense pressure prior to or during a competition. Orlick (1990) reported visual imagery which can be used to lower arousal includes picturing oneself far from a sport event. Orlick (1990) also incorporated kinesthetic imagery by adding sensations to this exercise such as muscle tension seeping out of the body into the air. According to these results, it can be concluded that visual and kinesthetic imagery can elicit and can be used to control physiological responses which typically occur in real-life situations. Therefore, athletes can rehearse these physiological changes and may be able to manipulate them with practice so as to achieve a level of arousal that enables their best performance in a given sport situation (White & Hardy, 1998).

Regulating competitive anxiety is an important component to successful performance as well. Results indicate that visual and kinesthetic imagery can be used to help an athlete control anxiety when used in conjunction with other methods (Hale & Whitehouse, 1998). For example, Kerr and Leath (1993) reported that stress inoculation therapy teaches the skills necessary to control anxiety and that these skills can be practiced through imagery. Using imagery in this way can be especially beneficial prior to a competitive situation because it enables the athlete to rehearse the skills they will need to control anxiety during the performance (Mace & Carroll, 1985). In other studies (Cogan & Petrie, 1995; VanDenberg & Smith, 1993) imagery was coupled with relaxation training and was found to reduce precompetition anxiety. Orlick (1990) also suggested that imagery rehearsal which incorporates relaxation therapy can help an athlete associate the skills necessary to control anxiety during a situation that is likely to cause it. Furthermore, Vadocz, Hall, and Mortiz (1997) found that motivational general-arousal imagery can be used as a predictor of an athlete's anxiety during a sport situation but not prior to it. Therefore, research investigating imagery and anxiety levels indicates that imagery can be used to rehearse skills learned in other forms of therapy, enabling the athlete to learn to control anxiety.

Visual Imagery Ability

Visual imagery ability is recognized as the ease with which an individual can visualize an image. Within the category of visual imagery, two perspectives have been identified (Mahoney & Avener, 19997). An individual imaging with an internal perspective visualizes the surroundings from a point-of-view within the body as if actually experiencing it. Imaging the environment, the manipulation of an object and/or a change in stimulus are therefore perceived from a first-person perspective. Research indicates that elite athletes tend to use an internal perspective when imaging more than nonathletes and that imagery enhances their performance (Mahoney & Avener, 1977; Rotella, Gansneder, Ojala, & Billing, 1980; Orlick & Partington, 1988; Patrick & Hrycaiko, 1998). Other studies reported that athletes prefer to use an internal perspective when rehearsing the technique of specific tasks which depend on perception of the surroundings in order to be performed correctly (Hardy, 1997; White and Hardy, 1995). An example of such a task is batting in baseball or softball. It would be appropriate for an athlete to use an internal perspective when rehearsing his/her performance at bat because execution of this skill is reliant upon stimuli from the environment.

An external perspective is used by individuals who image themselves from a point-of-view outside the body. Imaging with this perspective involves seeing oneself and the surrounding environment at the same time as though watching oneself on television. Vealey and Greenleaf (2001, p. 255) suggested that “an external imagery perspective can be useful in improving an athlete’s confidence if a highly successful performance is imaged.” Other information (Vealey & Greenleaf, 2001, p. 265) indicates that “using the external perspective is beneficial for emphasizing form as it offers the opportunity to visually perceive execution of a skill as a video camera would record it." Athletes can then use their own feedback without relying on equipment to improve their form and may become more consistent in using proper form each time they are called upon to do so in a competitive situation.

Kinesthetic Imagery Ability

Kinesthetic imagery ability is the ease with which an individual can feel an imaged movement or sensation. An internal perspective is used when imaging kinesthetically because the perceptions rehearsed are based upon feelings that occur within the body. An athlete is likely to feel several sensations at once while performing a movement; however, these feelings can be isolated and individually rehearsed when engaging in kinesthetic imagery. Moran and Macintyre (1998) identified four aspects of movement which were isolated in a qualitative study of kinesthetic imagery in world cup canoeists. The athletes reported kinesthetically imaging the feeling of pain and motion in the arms while rowing. They reported imaging the force of the water as it resisted the motion of the boat and paddles as well as the effort they applied with each stroke as they pulled themselves forward in the water. The canoeists also identified a spatial parameter in their use of kinesthetic imagery which incorporated the feel of waves against the canoe and the canoe's resistance.

A similar study investigated movement imagery also identifies force, effort, spatial elements, configuration of the limbs, and configuration of the hand as important keys to successful rock climbing (Smyth & Waller, 1998). The authors suggested that these are key components which rock climbers should include when imaging their routes as a method of rehearsal. In a study attempting to differentiate between visual and kinesthetic imagery during mental practice, Féry (2003) concluded that kinesthetic imagery is more beneficial than visual imagery for tasks that incorporate timing and coordination for successful execution. Based on the scant information available investigating kinesthetic imagery, it appears that kinesthetic imagery can be used to rehearse several aspects of a single movement and that kinesthetic imagery may be used to enhance performance.

Development of Imagery Abilities

Early research on the development of imagery abilities examines children's abilities to create and use static and kinetic images (Piaget, 1970; Piaget et al., 1960). It is theorized that a child can visually image and manipulate an object once he/she has established a series of reference points in space. This is a necessary component to imaging an object because visual and kinesthetic motor imagery involves linking an object to its position within a set of reference points. Piaget (1970) identified five levels in the development of reference systems and the imaging of an object in spatial movement. At level 1 a child bases the understanding of distance on topological information such as the endpoints of objects. The space filled by an object is not conceptualized until the second level when a child differentiates between objects fixed in space and moving objects which occupy space. At level 3 a child conceptualizes distance in one dimension and at level 4 can has mastered the interpretation of distance in two dimensions, thus allowing them to locate an object's exact position in space. At level 5, children recognize that points in space can be defined at the same time in two dimensions

(Piaget, 1970). According to this theory, a child becomes more spatially aware as they progress from one level to another and subsequently are more capable of conceptualizing the manipulation and coordination of an object's motion.

Research supporting this developmental theory reports that spatial awareness, the manipulation of objects, and the coordination of objects affect imagery ability and are better developed with age (Mwanalushi, 1974; Dean, 1976). Kosslyn et al. (1990) investigate age differences in image generation, image maintenance, image scanning and image rotation. The authors expected marked differences in imagery ability with age; however, a gap between the two older groups and two younger groups was the most pronounced finding. Results indicate that 14-year-olds and adults generate, scan and rotate objects better than 5-year-olds and 8-year-olds. However, children in these age groups exhibited similar competency in the four dimensions of imagery ability targeted and were more competent than anticipated. In a specific study, Wolf and Levin (1972) reported similar findings such that the ability to form dynamic visual images may develop between the ages of 5 and 8. Additionally, Ryan et al. (1987) reported that 5 and 6-year-olds are capable of forming visual, interactive imagery. These results indicate that that some children may progress through the stages described by Piaget (1970) very early in life and therefore young children may have the ability to visually image at an early age. Because of these individual differences, exact ages for each level have not been determined.

Research investigating the effectiveness of imagery for children of different ages generally examines visual imagery as a facilitator of paired associative learning. Several reports indicate that kindergartners can generate and use visual imagery in paired associative learning tasks if they are presented with materials to interact with (Wolff & Levin, 1972; Varley, Levin, Severson, & Wolff, 1974). Bender and Levin (1976) added to these results by reporting that kindergarten subjects can generate visual images prior to handling them if the children are instructed to plan how they will manipulate the objects. Further, Brody et al. (1978) described these planned images as anticipated imagery, reporting that children as young as 4 can produce visual imagery but that training is necessary in order for imagery to be used as a facilitator of learning. These reports on the effectiveness of imagery in young children yielded similar results such that young children can produce and use visual imagery to enhance learning when given specific instruction to do so.

In general, imagery as a teaching tool has been supported for children in elementary grades (Borduin et al., 1993; Moely, Hart, Leal, Santulli, Rao, Johnson, & Hamilton, 1992; Pressley, Johnson, Symons, McGoldrick, & Kurita, 1989). Additionally, several studies on visual imagery with children as the sample population have been shown to benefit performance in memory tasks for 3, 5, and 7-year-olds (Hoffman & Hawkins, 1980); second, fourth and sixth graders (Kulhavy, Canaday, Haynes, & Schallert (1977); and high school students (Hollenberg, 1970). Imagery has also been used to improve spelling performance in upper elementary students (Sears & Johnson, 2001). Pressley and Levin (1980) attempted to investigate visual imagery as a facilitator of learning in first and sixth graders. These authors concluded that younger children need more storage and retrieval prompts than older children in order to use visual imagery. Therefore, it is necessary to describe clear parameters for an experimenter's support in order to ensure that results are valid and reliable when investigating visual imagery use in this population. As research indicates, children of varying ages have the ability to generate, manipulate and use visual imagery for various tasks if given the appropriate imagery training.

Investigations into visual and kinesthetic imagery as a facilitator of physical or athletic performance in children are sparse. Li-Wei, Qi-Wei, Orlick, and Zitzelberger (1992) investigated the appropriateness of imagery training in 7-10-year-olds and concluded that visual and kinesthetic imagery can be used to enhance the performance in table tennis when used in conjunction with relaxation training. However, differences between the participants' visual and kinesthetic abilities were not analyzed. In a different study, Livesey (2002) investigated the visual imagery abilities of 10 and 14-year-olds concluding that children with high visual imagery abilities performed significantly better on tests of kinesthetic acuity than children who had lower visual imagery ability. Other research supported these results (Livesey & Kangas, 1997) such that a relationship exists between responses to the Visual Movement Imagery Questionnaire (Isaac & Marks, 1994) and two measures of kinesthetic acuity. However, Moritz, Hall, Martin, and Vadocz (1996) reported a correlation of .44 for the visual and kinesthetic imagery abilities as measured by the MIQ (Hall et al., 1985) indicating that these abilities are related but operate as separate constructs.

A different research study (Ille & Cadopi, 1999) investigated the affects of age and skill level on participants' visual and kinesthetic imagery ability for movement sequences in gymnastics. The sample population for their study was 30 skilled and 30 less-skilled children between the ages of 8 and 13 years. Visual imagery ability did not vary across age or skill level; however, their scores for kinesthetic imagery abilities were affected by these factors such that skilled gymnasts showed superior kinesthetic imagery ability until the ages of 10-11. The less-skilled gymnasts showed marked improvement in kinesthetic imagery ability between the ages of 8 -9 and again between the ages of 12-13. Furthermore, dance instructors reported using visual imagery more frequently than kinesthetic imagery with young beginners for specific skill enhancement yet increase the incorporation of kinesthetic imagery with older, more experienced children (Overby, 1990). Therefore, the information summarized on imagery ability in children indicates that children may be capable of visually imaging before they can kinesthetically image. Based on these results, it may be that visual imagery ability develops earlier in life than kinesthetic; however, more research is needed to address age differences in imagery ability.

Physical Activity and Imagery

One of the components of imagery ability in adults and youth is an individual's experience with the physical activity imaged. Psychoneuromuscular theory suggests that electric activity in the muscles while imaging is similar to that while actually moving. It is possible that imaging may be facilitated by previous motor schemas already developed in an individual who has physical experience with the movement imaged. Furthermore, according to the symbolic learning theory, individuals who have prior motoric experience to draw upon are more likely to exhibit strong imagery abilities because the symbolic representation of a movement is already developed. Similarly, bioinformational theory asserts that as individuals gain physical experience they also gain responses to sport situations which are stored in memory. Consequently, imaging a desired performance is easier for them because they have more responses to reference. All of these theoretical explanations of how imagery functions as a facilitator of performance indicate that prior physical activity may be an important component to imagery ability.

Consistent throughout the literature investigating the effectiveness of imagery is the finding that physical practice facilitates performance to a greater degree than imagery rehearsal of the performance (Hird, Landers, Thomas, & Horan, 1991; Vealey & Greenleaf, 2001). Yet Hall et al. (1990) concluded that imagery is effective in learning a skill when it is used in conjunction with physical practice. This is because physical practice is a critical method for experiencing and understanding the components of a skill so they can be mastered. Therefore, engaging in activities which allow an individual to physically practice and experience a skill is critical to learning the components of a skill. Thus individuals who engage in physical activities regularly will have more information available to image these activities for performance enhancement later, and may have better developed imagery abilities as a result.

In a specific study, (Hillman, Motl, Pontifex, Posthuma, Stubbe, Boomsma, & de Geus, 2006) the effects of physical activity on cognitive function were examined in adults and high school students. The results indicate that physical activity is associated with improved reaction time and response accuracy for this population. Therefore, if physical activity improves these aspects of cognitive function, then it is possible that it may have an influence on the cognitive processes of imagery ability as well. In another study, (Bird, 1984), EMG activity was recorded for athletes imaging a movement. This EMG activity was congruent with the EMG activity recorded during actual execution of the movement. As suggested by the psychoneuromuscular theory, the results of this study indicate that similar physiological activity may occur during imagery and physical activity. This data has implications for the present study because the athletes' ages ranged from 12 – 33 years indicating that children of middle and high school exhibit similar physiological activity to adults while imaging. If this is the case, then the theoretical explanations of how imagery functions may be applicable to children of middle and high school age as well.

Bird (1984) also pointed out that the movement imaged was familiar to each of the participants. This follows with Weiss' (1991) evaluation of the psychological development of skills in children and adolescents which reports that the more knowledgeable children are about sport specific skills the stronger children's imagery abilities will be. This may be because adequate understanding of the physical and mental requirements needed to successfully execute a skill makes a child more likely to analyze and subsequently image the performance accurately. Given these results, this study will attempt to examine the potential influence of habitual physical activity on children's imagery ability.

Summary

The theoretical explanations for how imagery functions include psychoneuro-muscular, symbolic learning, attention set arousal and bioinformational theories. These theories present physiological and cognitive aspects of how imagery functions. Two general categories of imagery function have been identified. The first function, cognitive imagery, incorporates visual or kinesthetic rehearsal of specific skills and general strategies of performance. The second function is motivational imagery. Motivational specific imagery involves the rehearsal of emotions that result from achieving a goal.

The categories of imagery ability most thoroughly researched are visual and kinesthetic, however a disproportionate amount of the literature available on imagery investigates the effectiveness of visual imagery ability. Though imagery ability has been shown to facilitate performance in adults, little information has investigated this topic which children as the sample population. Of the information available regarding the development of imagery ability, results indicate that children may be capable of visually imaging before they can kinesthetically image and that visual imagery ability develops earlier in life than kinesthetic. More research is needed to address age differences in imagery ability as little research is available on the visual and kinesthetic imagery abilities in children at all.

Lastly, the theories which attempt to explain how imagery functions incorporate prior knowledge of the skill as a component to imaging it. Physical activity shows greater facilitative effects on performance than imagery alone; however the affect of physical activity on imagery ability has not been investigated. This study will attempt to fill the gap in the literature regarding children's imagery abilities while also investigating habitual physical activity as a covariate of imagery ability.

CHAPTER 3

Methods

Participants

Male and female middle and high school students were recruited to volunteer to participate. The 93 middle school students who participated were enrolled in grades six or seven at the time of testing. The mean age for the middle school participants was 12.2 years (*SD* = .65) and this age group consisted of 58 females and 35 males. The 99 high school students who participated were enrolled in grades ten or eleven at the time of testing. The mean age for the high school participants was 16.0 years (*SD* = .88) and this age group consisted of 56 females and 42 males. All participants were enrolled at a Charter School in the Southeast region of the United States at the time of testing and received extra credit for participating. None of the participants had lower leg deformities, injuries or congenital disorders. Data collected from students previously diagnosed with learning differences and/or disabilities as reported to the school was not be included in data analysis.

Instruments

The Revised Movement Imagery Questionnaire (MIQ-R) (Hall & Martin, 1997) was completed by all middle and high school participants (Appendix B). The MIQ-R was administered to assess the participants' abilities to use visual and kinesthetic imagery. The 8 item questionnaire was measured on a 7 point Likert scale (1 = very hard to image, 7 = very easy to image). Each of the 8 items involved a different movement, 4 of which the participants were asked to image visually and the remaining 4 kinesthetically. The questionnaire consisted of two subscales: visual imagery ability and kinesthetic imagery ability. The Movement Imagery Questionnaire (Hall & Pongrac, 1983) has a test-retest coefficient of .83 for a 1 week interval (Hall et al., 1985) and Atienza et al. (1994) reported internal consistencies for the visual (.89) and kinesthetic (.88) subscales. The MIQ-R which was used in the present study is significantly correlated with the MIQ on both subscales (Hall & Martin, 1997).

The Baecke Questionnaire of Habitual Physical Activity (Baecke, Burema & Fritjers, 1982) was used to estimate the participants' routine engagement in physical activity (Appendix C). The Baecke Questionnaire of Habitual Physical Activity (BQHPA) was originally developed to assess adult physical activity in work, sport and leisure time. Therefore, it was modified for preadolescent and adolescent students such that questions regarding physical activity at work evaluated physical activity during the daily routine at school instead. The three subscales were physical activity at school, participation in sports, and physical activity during free time. The BQHPA consisted of 13 items which were scored on a 5-point Likert scale (1 = Never, 5 = Always). The validity and reliability of the BQHPA has been previously reported (Philipaerts & Lefevre, 1998; Philippaerts, Westerterp, & Lefevre, 1999) and was used to assess physical activity in 12-18-year-olds in a previous study (Deforche, Lefevre, De Bourdeaudhuij, Hills, Duquet, & Bouckaert, 2003).

Procedures

Prior to collecting data, a parent consent form (Appendix D) and assent form (Appendix E) was distributed to all sixth, seventh, tenth and eleventh grade students while in school. The participants were given two weeks to discuss the forms with their legal guardians, sign and return them.

The MIQ-R was administered by the researcher or research assistant in a semi-private location. The assistant was another teacher from the charter school. At no time did the researcher or research assistant administer the MIQ-R to a student enrolled in a course taught by that individual. A script of general instructions was read to each participant explaining the procedures of the MIQ-R. This script of instructions was also posted at the top of each participant's questionnaire. The researcher and/or assistant verbally described and physically modeled each movement before instructing the participant to produce the same movement. Each movement was described and modeled by the tester or assistant before being performed by the student. Once the participant completed the movement, the tester or assistant will instructed him/her to kinesthetically or visually image the movement. Finally, the participant assessed his/her ability to feel or see the movement and indicated the level of ease for this mental task on the questionnaire.

The BQHPA was administered by the researcher and/or assistant during a regularly scheduled science class. The assistant was another teacher from the charter school. At no time did the researcher or research assistant administer the BQHPA to a student enrolled in a course taught by that individual. The researcher or assistant read a script explaining the general instructions for completing this questionnaire. This script was posted at the top of each participant's copy of the BQHPA. The participants were given twenty minutes to complete the questionnaires.

Design Analysis

The independent variable was the age group of the participants (middle school age or high school age) and imagery ability (visual or kinesthetic). Habitual physical activity was examined as a covariate of visual and kinesthetic imagery abilities for all participants.

The results of this study were analyzed using a 2x2 (age by imagery ability) mixed model ANCOVA with the three subscales of habitual physical activity (physical activity at school, participation in sports, physical activity during free time) as covariates. This was used to determine if the hypotheses would be accepted or rejected at the .05 alpha level.

Data will be analyzed using the statistical package for social sciences software (SPSS 12.0 for Windows, Student Version).

CHAPTER 4

Results

The MIQ-R was used to investigate the middle and high school participants' visual and kinesthetic imagery abilities. The BQHPA was used to investigate three components of the middle and high school participants' habitual physical activity. This included habitual physical activity in school, in sport and during leisure time. The purpose of this study was to investigate age differences (i.e. middle and high school participants) in visual and kinesthetic imagery abilities. Furthermore, this study investigates whether habitual physical activity has an influence on these imagery abilities. Prior to running statistical analyses to investigate these topics, the data was screened for outliers and tested for normality. Each of the MIQ-R subscales (visual imagery ability and kinesthetic imagery ability) and BQHPA subscales (physical activity in school, sport and leisure time) were also tested for reliability. Data collected from reliable subscales of the MIQ-R and BQHPA were analyzed and results are listed below.

Data Screening

The mean of the participants' responses to each subscale of the MIQ-R and BQHPA questionnaires were converted to Z scores to determine if outliers existed. Three univariate outliers (Z scores outside the range ±4) were deleted from the data set. Two of these outliers were removed from the kinesthetic imagery ability subscale of the MIQ-R, and one was removed from the visual imagery subscale of the MIQ-R. One multivariate outlier was also removed based on Mahalanobis Distance ($p<.001$) which was outside of the acceptable range.

Data was tested for skewness and kurtosis values. Data for the MIQ-R visual subscale and MIQ-R kinesthetic subscale were skewed with values greater than – 1. Following Tabachnick and Fidell (1996) guidelines, the visual and kinesthetic subscales were then transformed with an inverse square root. Thus, lower values in both visual and kinesthetic subscales reflect higher imagery abilities in both subscales.

Descriptives and Reliability Analysis

Data was collected from a total sample of 196 participants. However, after screening of the data and removal of univariate and multivariate outliers, the final sample size was 192. Participants were high and middle school students from a south Florida charter school. Both kinesthetic and visual imagery abilities were measured with the MIQ-R. Habitual physical activity at school, in sport and during leisure time was measured with the BQHPA. See table 1 for descriptives.

Table 1: Descriptive Statistics for Converted Means of MIQ-R and BQHPA Subscales by Age Group

AgeGroup		KIA Trans.	VIA Trans.	Phys. Act. School	Phys. Act. Sport	Phys. Act. Leisure
Middle School	Mean	1.3840	1.3349	3.1742	3.0903	3.0584
	N	93	93	93	93	93
	Std. Deviation	.24715	.23929	.40025	1.26886	.62171
High School	Mean	1.4167	1.3155	3.0303	2.9737	3.1371
	N	99	99	99	99	99
	Std. Deviation	.27284	.29344	.43176	1.24364	.64888
Total	Mean	1.4009	1.3249	3.1000	3.0302	3.0990
	N	192	192	192	192	192
	Std. Deviation	.26055	.26806	.42191	1.25399	.63543

The reliability of each subscale was assessed using Cronbach's alpha. All of the subscales were reliable with the exception of the physical activity at school subscale of Baecke's Habitual Physical Activity Questionnaire ($\alpha = .157$). This subscale will be excluded from the statistical analysis to test each one of the hypothesis. See table 2.

Table 2: Reliability of MIQ-R and BQHPA Subscales.

Subscale	**Cronbach's alpha**
Kinesthetic Imagery Ability (KIA)	.688
Visual Imagery Ability (VIA)	.740
Physical Activity at School	.157
Physical Activity in Sport	.863
Physical Activity During Leisure Time	.704

Hypothesis One

Middle school students will exhibit greater visual imagery ability than kinesthetic imagery ability while controlling for habitual physical activity in sport and leisure time.

Results fail to support this hypothesis. Middle school students did not exhibit significant differences in visual and kinesthetic imagery abilities. A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between age group (i.e., middle school and high school) and type of imagery (i.e., visual and kinesthetic) while controlling for habitual physical activity in sport and during leisure time. The Age Group x Imagery Ability interaction ($F(1,188) = 1.689$, $p > .05$, $\eta^2_p = .009$) was not significant. Age group did not differ in visual or kinesthetic imagery abilities.

Hypothesis Two

There will be no difference in visual and kinesthetic imagery abilities for high school students while controlling for habitual physical activity in sport and leisure time.

Results support this hypothesis. High school students did not exhibit significant differences in visual and kinesthetic imagery abilities. A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between age group (i.e., middle school and high school) and type of imagery (i.e., visual and kinesthetic) while controlling for habitual physical activity in sport and during leisure time. The Age Group x Imagery Ability interaction ($F(1,188) = 1.689$, $p > .05$, $\eta^2_p = .009$) was not significant. Age group did not differ in visual or kinesthetic imagery abilities.

Hypothesis Three

High school students will exhibit greater visual and kinesthetic imagery abilities than middle school students while controlling for habitual physical activity in sport and leisure time.

Results fail to support this hypothesis. High school students did not exhibit higher imagery abilities than middle school students. A 2 x 2 mixed model ANCOVA was calculated to examine differences in imagery ability between age group (i.e., middle school and high school) while controlling for habitual physical activity. The main effect for age group ($F(1,188) = .018$, $p > .05$, $\eta^2_p = .000$) was not significant. Imagery abilities did not differ between age groups.

Hypothesis Four

Students with greater physical activity at school will exhibit greater imagery abilities than students with lower physical activity at school.

The Cronbach's alpha level of the BQHPA physical activity at school subscale was .157. Therefore, this hypothesis was not tested due to the subscale's lack of reliability.

Hypothesis Five

Students with higher participation in sport will exhibit greater imagery abilities than students with lower participation in sport.

Results support this hypothesis. A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between type of imagery (i.e., visual and kinesthetic) and habitual physical activity in sport. The Imagery Ability x Habitual Physical Activity in Sport interaction ($F(1,188) = 3.451$, $p = .065$, $\eta^2_p = .018$) was approaching significance. Students with greater habitual activity in sport exhibited greater visual and kinesthetic imagery abilities than students with lower habitual activity in sport. Results are displayed in table 3, and figure 1.

Table 3: Descriptive Statistics for the Imagery Abilities of High School Students Grouped by High and Low Levels of Habitual Physical Activity in Sport

Phys. Act. Sport		KIA Transf.	VIA Transf.
Low	Mean	1.4218	1.3388
	N	102	102
	Std. Deviation	.26886	.27551
High	Mean	1.3771	1.3091
	N	90	90
	Std. Deviation	.25018	.25998
Total	Mean	1.4009	1.3249
	N	192	192
	Std. Deviation	.26055	.26806

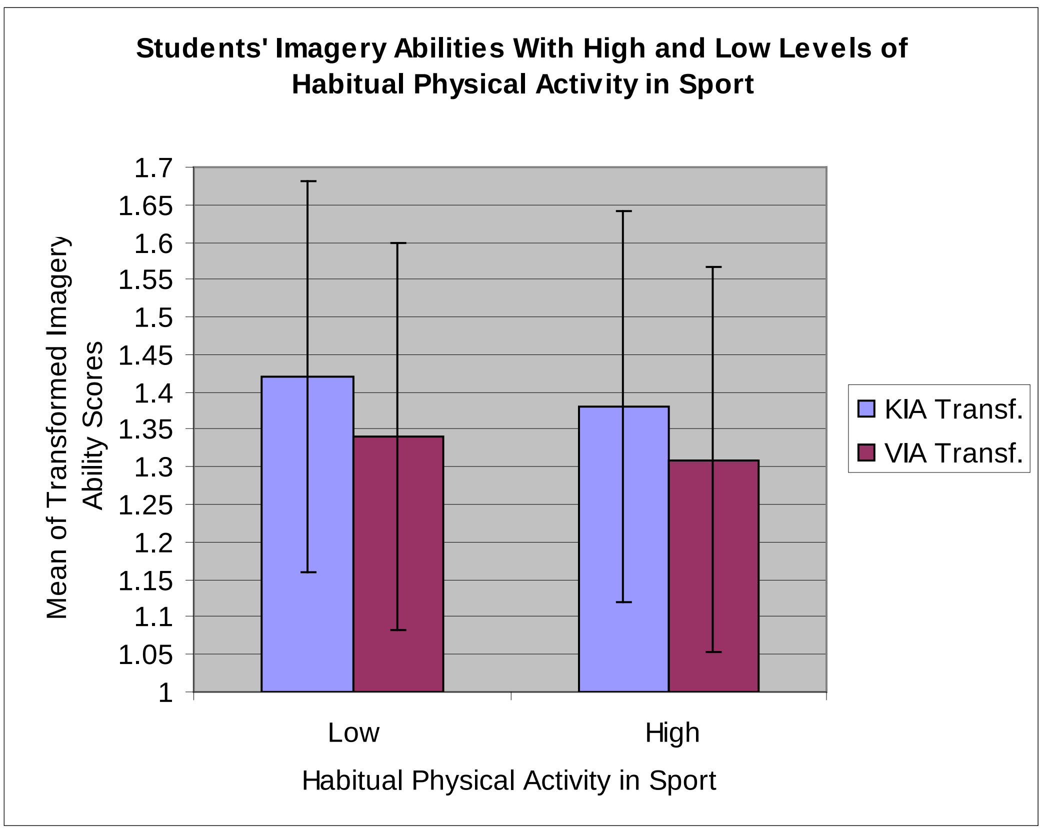

Figure 1: Transformed Visual and Kinesthetic Imagery Abilities Scores of Students with High and Low Levels of Habitual Physical Activity in Sport

Hypothesis Six

Students with higher physical activity during their leisure time will exhibit greater imagery abilities than students with lower physical activity during their leisure time.

Results fail to support this hypothesis. A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between type of imagery (i.e., visual and kinesthetic) and habitual physical activity during leisure time. There was not a significant interaction of imagery type by physical activity during leisure time ($F(1,188) = 1.689$, $p>.05$, $\eta^2_p = .009$).

CHAPTER 5

Discussion

The purpose of this study is to investigate age differences in the visual and kinesthetic imagery abilities of middle and high school students as well as to examine habitual physical activity as a potential influence on both of these imagery abilities. Given that visual imagery has been shown to enhance children's performances in a variety of tasks (Hollenberg, 1970; Hoffman & Hawkins, 1980; Sears & Johnson, 2001; Bull & Wittrock, 1973; González, Campos, & Pérez, 1997; Hanrahan & Salmela, 1990; Sweigard, 1974), further investigation in this topic is necessary to determine how imagery use can be used to benefit the performance of children.

Furthermore, a gap in the literature exists regarding children's use of kinesthetic imagery ability as this topic has not been adequately investigated. Additionally, results conflict regarding age differences in imagery abilities (Piaget, Inhelder, & Szeminska, 1960; Dean, 1976; Wolff & Levin, 1972; Pressley & Levin, 1980; Livesey, 2002; Kosslyn et al., 1990; Borduin, Borduin, & Manley, 1993; Willoughby, et al., 1999; Brody et al., 1978; Ryan, Ledger & Weed, 1987) and older children (middle school and high school age) are underrepresented in the literature (Ille & Cadopi, 1999). More information is needed to clarify this topic. Lastly, information exists which indicates that physical activity may have an affect on imagery ability (Ozel, Larue & Molinaro, 2004; Overby, 1990); however, this line of research has not been explored with children as the sample population.

Summary of Analyses

Following Tabachnick and Fidell (1996) guidelines, the visual and kinesthetic subscales were transformed with an inverse square root. Thus, lower values in both visual and kinesthetic subscales reflect higher imagery abilities in both subscales. A 2 x 2 mixed model ANCOVA was calculated to examine differences in imagery ability between the two age groups (middle school and high school) and within two types of imagery (visual and kinesthetic) while controlling for habitual physical activity (in sport and during leisure time).

Hypotheses One

Middle school students will exhibit greater visual imagery ability than kinesthetic imagery ability while controlling for habitual physical activity in sport and leisure time.

The results fail to support this hypothesis. It was expected that the visual imagery ability scores of middle school students would be greater then their kinesthetic imagery ability scores because other findings indicate that visual imagery ability is greater then kinesthetic imagery ability at this age (Ille & Cadopi, 1999). In a comparison of the visual and kinesthetic imagery abilities of gymnasts in three age groups (8-9, 10-11 and 12-13), the visual imagery abilities were consistent across age groups and remained higher then kinesthetic for each. This indicates that the visual imagery processing components were already developed for this sample population and the authors report that age did not significantly influence visual imagery ability scores though it did influence their kinesthetic scores.

The results of the current study conflict with this prior research as no significant difference was found between visual and kinesthetic imagery abilities. A different line of research may explain these results. Livesey (2002) reported that a relationship exists between visual imagery ability and kinesthesis such that greater visual imagery ability is associated with greater kinesthetic acuity. The author concluded that this relationship develops between the ages of 10 and 14 (middle school age). If this relationship does exist for children in this age range, then middle school students may have a better-developed kinesthetic sense as a result. It follows that with a better-developed kinesthetic sense middle school students would be more likely to exhibit greater kinesthetic imagery abilities. It may be that this relationship reduces the gap between visual and kinesthetic imagery abilities as reported by Ille and Cadopi (1999); thus, explaining why there were no significant differences for the visual and kinesthetic imagery abilities of the participants in the present study. Based on these results and the ones from earlier research (Fishburne 1990), it can be concluded that kinesthetic imagery processing components may develop before a child reaches middle school age and may continue to develop while at middle school age. Thus, no significant differences in imagery abilities exist for the middle school students in the present study as they may have already developed both the visual and kinesthetic imagery processing components prior to reaching middle school age.

When evaluating these results it is important to consider the validity of a self-report measure for children. Identical instructions were given to all participants such that each was asked to "Rate how easy or difficult it is for you to imagine seeing or feeling the movement you just performed." Livesey (2002) modified the instructions of the

VMIQ given to 10 and 14-year old participants by asking them to rate the “clearness” of the “picture in your head” (p. 282). Additionally, Livesey (2002) described each value of the scale in terms of “clearness” with the extreme values most thoroughly described. For example, 1 = “no image at all, you only know that you are thinking of the skill” and 5 = “an image that is perfectly clear, as clear as if you were actually seeing it” (p. 282). Results of this study also indicate that there was no significant difference in the mean visual imagery scores of the two age groups; however, Livesey (2002) concluded that this measure can be problematic when used with children.

The MIQ-R scale used in the present study includes 7 values and displayed them as “7 = very easy to feel or see, 6 = easy to feel or see, 5 = somewhat easy to feel or see, 4 = neutral, 3 = somewhat hard to feel or see, 2 = hard to feel or see, 1 = very hard to feel or see.” It is possible that this scale did not adequately describe ease of producing an image which would qualify as a 6 or 7 on the scale; therefore, participants may have overestimated their abilities to create such an image and thus, inaccurately assessed their own imagery abilities. If the participants consistently overestimated their imagery abilities then similarly high means would occur and significant differences would not be detected.

Hypothesis Two

There will be no difference in visual and kinesthetic imagery abilities for high school students while controlling for habitual physical activity in sport and leisure time.

The results support this hypothesis because no significant difference was found for the visual and kinesthetic imagery abilities of the high school students. These results were expected because earlier research indicates that visual imagery abilities are generally greater then kinesthetic imagery abilities in late childhood and early adolescence (Ille & Cadopi, 1999) but not for college students (Féry, 2003). In a related investigation, Féry (2003) attempted to differentiate visual and kinesthetic imagery for college students (mean age = 21.9 years, SD = 3.1) by comparing the results of training (kinesthetic imagery, visual imagery or control) on their performance of a drawing task. The participants who underwent visual imagery training outperformed the other two groups in form reproduction, while the group who underwent kinesthetic imagery training outperformed the other groups in movement duration. Therefore the college students were capable of visually and kinesthetically imaging the movements, however they focused on different aspects of the movement while doing so. It is possible that high school participants of the present study exhibited no significant differences in their visual and kinesthetic imagery abilities because they were also focusing on different aspects of the MIQ-R movements.

Hypothesis 3

High school students will exhibit greater visual and kinesthetic imagery abilities than middle school students while controlling for habitual physical activity in sport and leisure time.

The results fail to support this hypothesis. Within the available literature on development of imagery abilities, one line of research points to age as an integral component to the development of imagery abilities (Piaget, Inhelder and Szeminska, 1960). Piaget and his colleagues identified 5 levels of imagery ability that are directly related to spatial awareness and therefore indirectly related to age. Later research investigating imagery abilities also reported significant differences in imagery abilities across age groups (Mwanalushi, 1974; Dean, 1976). For example, Kosslyn et al. (1990) expected marked differences in visual imagery ability with age; however, the results indicated that the sample did not exhibit increased visual imagery ability in increments but rather a marked polarity in visual imagery occurred across the age groups such that the two older groups and two younger groups were significantly different. The 14-year-olds, individuals of late middle school age, and adults produced visual mental images with similar ease and performed better than 5-year-olds and 8-year-olds.

These results are significant to the interpretation of the present study because the 14-year-olds (late middle school age) showed similar visual imagery abilities to adults; therefore, it is possible for middle school students to exhibit well-developed visual imagery ability according to these findings. Thus, it is expected that individuals belonging to an age group between middle school and adulthood (i.e. high school participants) would be likely to exhibit similar imagery abilities to the younger and older age group. Kosslyn et al. (1990) conclude that there were not significant differences in the middle school age participants and adult participants because imagery processing components are developed by the age of five. The authors also conclude that these visual imagery processing components become more specialized with age which accounts for the differences in imagery abilities amongst the oldest and youngest age groups. This may explain the results of the present study wherein no significant differences were found for middle and high school age groups because these visual imagery components are already developed and specialized.

The results of the present study also indicate that there were no significant differences in the kinesthetic imagery abilities of middle and high school participants Contrary to our findings, past research has shown that visual imagery ability appears to develop before kinesthetic imagery ability (Ille & Cadopi, 1999). These authors conclude that when comparing three age groups (8-9, 10-11 and 12-13) visual imagery ability was higher then kinesthetic for each age group and the highest kinesthetic imagery abilities were reported for the oldest age group of less-skilled gymnasts, who were of middle school age. Given these results, the development of kinesthetic imagery processing may take place prior to or during the first year of middle school. This suggests that no significant difference would be reported for the kinesthetic imagery abilities of the middle and high school students because both age groups have already developed and specialized kinesthetic imagery processing components.

When interpreting the results of data collected with a questionnaire it is also important to evaluate the measurement being used. The measurement utilized in this study was the MIQ-R. Variations of the MIQ-R have been used with participants of middle school age in earlier research (Ille & Cadopi, 1999; Livesey, 2002). Even when using reliable questionnaires which have been validated such as the MIQ-R, it is necessary to assume that the questions and scale are understood by the participants with any sample population. Livesey (2002) reported that using questionnaires with children can be problematic because there is the possibility that children will misunderstand the terms of the questionnaire despite offering extensive verbal and written instruction.

Similar instructions were given to all participants of the present study, yet they may have been unclear for some. It may be that the MIQ-R was misinterpreted by some of the participants and consequently the data collected may not accurately reflect the participants' imagery abilities.

Hypothesis Four

Students with greater physical activity at school will exhibit greater imagery abilities than students with lower physical activity at school.

This hypothesis could not be tested because the subscale of the BQHPA, which was used to collect data on the participants' physical activity at school, was not reliable for the present study. The original version of the BQHPA was created for adults and includes three subscales: physical activity at work, in sport and during leisure time. Because the participants of the present study are middle and high school students, some items were modified in order to make the measurement more appropriate for the sample. In particular, the physical activity at work subscale was modified to be a physical activity at school subscale such that the word "school" was substituted for the word "work". While administering the questionnaires, the participants were encouraged to ask any questions they might have regarding the BQHPA items or scale. Questions 1-5 belonged to the physical activity at school subscale and were the items which the participants asked about most frequently. For some of the students these items may have elicited obvious responses, while they seemed confusing for others. It can be concluded that modifying a questionnaire originally created for adults so that it is more appropriate for children is problematic. Furthermore, attempting to make a questionnaire more appropriate for children does not eliminate the possibility that the participants may misinterpret the terms of the questionnaire despite extensive verbal and written instruction.

Though the BQHPA was found to be valid and reliable for 12-18-year-old participants (Deforche et al., 2003), it is possible that the BQHPA can be a reliable measure for one sample population of children but not for a different sample population of children. In another study (Deforche, De Bourdeaudhuij & Tanghe, 2006) assessing the attitudes of 90 adolescents (mean age = 14.6, SD = 1.0) toward physical activity the work subscale was omitted entirely instead of modified. The remaining subscales, physical activity in sport and leisure time were found to be valid and reliable as they were in the present study as well. Therefore, modifying the BQHPA from its original format with the intention of administering it to children such that the work subscale becomes a school subscale can alter the reliability of the subscale.

Hypothesis Five

Students with higher participation in sport will exhibit greater imagery abilities than students with lower participation in sport.

Results from this study support this hypothesis. The results of the present study indicate that the students who participate in sport more frequently then their peers exhibited greater visual and kinesthetic imagery abilities. In a study investigating the visual and kinesthetic imagery abilities of gymnasts, the authors found that the kinesthetic imagery ability of the gymnasts was significantly affected by skill level (Ille & Cadopi, 1999). Mumford and Hall (1985) also report that kinesthetic imagery ability is affected by skill level for figure skaters. Given these results, it is possible that an individual with greater participation in sport may also possess higher skill levels, and consequently greater kinesthetic imagery abilities. The present study did not investigate skill level as a component of imagery but did hypothesize that participation in sport would be associated with greater imagery abilities. Furthermore, Ille and Cadopi (1999) and Mumford and Hall (1985) reported that skill level did not significantly influence visual imagery ability. This is possibly due to the fact that processing components were already developed for those participants; therefore, their visual imagery ability scores were greater. The results of the present study conflict with those findings such that students of middle and high school age who frequently participate in sport did exhibit greater visual imagery ability.

Hypothesis Six

Students with higher physical activity during their leisure time will exhibit greater imagery abilities than students with lower physical activity during their leisure time.

The results fail to support this hypothesis because no significant interaction was found for physical activity during leisure time and kinesthetic imagery ability. Additionally, no significant interaction was also found for physical activity in sport and visual imagery ability either. These results are unexpected given that an interaction was found for habitual physical activity in sport and both imagery abilities. It was expected that greater physical activity in leisure time would yield results similar to those of greater participation in sport because physical activity in general has been shown to influence imagery abilities in adults (Ozel et al., 2004) and middle and high school students have been shown to exhibit similar physiological activity to adults while imaging (Bird, 1984). Given these results, physical activity in general may also have an effect on the imagery abilities of middle and high school students regardless of the when this physical activity occurs. Therefore, a significant interaction was expected for physical activity during leisure time and imagery abilities, however the results of this study do not indicate that such an interaction exists. This may be due to the instrument being used to collect data. In the original form of the BQHPA, questions 7-13 belong to the leisure time subscale; however, the word "free" was substituted for the word "leisure" to eliminate confusion for the participants. It is possible that the participants still had a difficult time conceptualizing and accurately rating their physical activity during leisure activities, and may have interpreted "free time" as parts of the day when they were permitted to rest or relax. If this did occur, then the participants would have underestimated their physical activity during leisure time and consequently an interaction is not reported.

Limitations

1. Although the MIQ-R has been used with children as the sample population in prior research (Ille & Cadopi, 1999), the data collected with the MIQ-R may not accurately reflect the visual or kinesthetic imagery ability of the participants. The participants may have misinterpreted the instructions or questionnaire items; thus, altering the validity of the measurements.
2. Although the BQHPA has been used with children as the sample population in prior research (Deforche et al., 2003), it may have been confusing for the

participants to conceptualize and subsequently rate their habitual physical activity with this instrument.

3. The participants were asked to complete the questionnaires in small groups of 2-5 individuals at a time. It is possible that some of the participants were uncomfortable asking for clarification in a group setting, or did not answer accurately as a result of the group they were in.

Recommendations for Future Research

1. Collect data from student populations of different regions of the United States.
2. Collect data from varying age groups (e.g., preschool, elementary grades 1-5, middle school grade 8, high school grades 10, 12).
3. Investigate imagery abilities in students with varying levels of athletic experience (e.g., sports played, number of years played).
4. Investigate imagery abilities in students with varying skill levels (e.g., novice, intermediate, advanced).
5. Investigate the intelligence quotients of students who exhibit visual and kinesthetic imagery abilities.
6. Validate a measurement of imagery abilities which is appropriate for children of multiple ages and has lower potential for misinterpretation. Perform an exploratory study on the visual and kinesthetic imagery abilities of children of various age groups.
7. Validate a measurement of habitual physical activity in school which is appropriate for children of multiple ages and has lower potential for

misinterpretation. Perform an exploratory study on the habitual physical activity levels of children of various age groups.

8. Compare children's habitual physical activity self-report responses to parental assessment of their child's habitual physical activity.

Summary

The imagery abilities of middle and high school students are not influenced by age group at this level. The visual and kinesthetic imagery abilities of middle school students are not significantly different when controlling for habitual physical activity in sport and leisure time. Likewise, the visual and kinesthetic imagery abilities of high school students are not significantly different when controlling for habitual physical activity in sport and leisure time. Furthermore, high school students did not exhibit imagery abilities that were significantly different from those of middle school students. Both middle and high school student with greater habitual activity in sport exhibited greater visual and kinesthetic imagery abilities than their peers with lower habitual activity in sport, however there was no significant interaction for habitual physical activity during leisure time and imagery abilities. Lastly, the MIQ-R may not be a valid instrument of visual and kinesthetic imagery abilities for children between the ages of 10-17. Thus, an alternative measure must be validated in order to assess the imagery abilities of children within this age range.

Appendix A

Running Head: DIFFERENCES IN IMAGERY ABILITIES

Differences in Visual and Kinesthetic Imagery Abilities as Controlled by the Habitual Physical Activity of Middle and High School Students

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ABSTRACT

The purpose of this study was to investigate age differences in the visual and kinesthetic imagery abilities of middle ($n = 93$) and high school ($n = 99$) students as well as to examine the potential influence of habitual physical activity in sport and during leisure time on both of these imagery abilities. The participants completed two questionnaires: the MIQ-R (Hall & Martin, 1997) and the BQHPA (Baecke, Burema & Fritjers, 1982). The results of this study were analyzed using a 2x2 (age by imagery ability) mixed model ANCOVA with two subscales of habitual physical activity (participation in sports and physical activity during free time) as covariates. Middle school and high school students did not exhibit significant differences ($p>.05$) in visual and kinesthetic imagery abilities. High school students did not show significant higher imagery abilities than middle school students ($p>.05$). The Imagery Ability x Habitual Physical Activity in Sport interaction was approaching significance ($p=.06$). A trend may exist for the participants with high levels of physical activity in sport as they may exhibit greater visual and kinesthetic imagery abilities than their peers with low habitual physical activity in sport. Lastly, it is recommended that an alternative instrument be created which assesses the visual and kinesthetic imagery abilities of children.

Imagery involves the mental creation or recreation of an experience which incorporates all of the senses. Athletes use mental imagery to attain their goals and improve performance. Several theories present explanations for how imagery functions. Psychoneuromuscular theory is based upon physiological evidence suggesting that imagery is strongly linked to muscle innervation which is due to messages sent from the brain to the muscles while imaging a movement. This activity may enhance the likelihood that a desired movement is performed when needed. Alternately, symbolic learning theory suggests that a movement is more likely to be correctly executed when it is familiar to an athlete. According to this theory, imaging a movement makes it more familiar and allows an athlete to plan it in advance.

Attention set arousal theory puts the physiological elements of the psychoneuromuscular theory and cognitive elements of the symbolic learning theory together in an explanation which posits that an athlete must sustain an optimal state of arousal to execute movement and focus on the task at hand. Lastly, bioinformational theory identifies stimulus propositions (environmental information) and response propositions (behaviors, thoughts, and feelings) as key components to imagery processing and further asserts that imagery allows an athlete to target and rehearse desired responses which makes these responses more likely to occur when needed.

Visual imagery ability is recognized as the ease with which an individual can visualize an image. Within the category of visual imagery, two perspectives have been identified (Mahoney & Avener, 19997). An individual imaging with an internal perspective visualizes the surroundings from a point-of-view within the body as if actually experiencing it. Kinesthetic imagery ability is the ease with which an individual can feel an imaged movement or sensation. An internal perspective is used when imaging kinesthetically because the perceptions rehearsed are based upon feelings that occur within the body. An athlete is likely to feel several sensations at once while performing a movement; however, these feelings can be isolated and individually rehearsed when engaging in kinesthetic imagery.

Visual and kinesthetic imagery are of primary interest to coaches and athletes as a means of enhancing performance. Consequently, imagery has been used as a tool to enhance performance in several ways. The two functions of visual and kinesthetic imagery which are identified according to Paivio's Two-Dimensional Model (1985) are cognitive and motivational. According to this model, visual and kinesthetic imagery influences the cognitive and motivation response systems which subsequently influence motor behavior. Hall, Mack, Paivio, and Hausenblaus (1998) revised this model by identifying components within the cognitive and motivational functions and further classifying them.

Research such as this has also been carried out with children to investigate the development of visual and kinesthetic imagery by examining age differences in imagery abilities (Kosslyn, Margolis, Barrett, Goldknopf, & Daly, 1990). In some studies basic instruction on the imagery type to be assessed (Livesey, 2002; Willoughby, Porter, Belsito, & Yearsley, 1999; Pressley & Levin, 1980; Brody, Mattson, & Zuckerwise, 1978;) or general prompts (Hoffman & Hawkins, 1980; Wolf & Levin, 1972; Youniss & Dean, 1970) were given by the researcher(s) to ensure that the participants created and used imagery as imagery ability was the variable measured. With minimal instruction provided in these studies the results describe developmental differences or similarities in imagery abilities as a function of age rather than improved performance as a function of imagery training.

Piaget, Inhelder and Szeminska (1960) theorized that in order for a child to visually manipulate an object, he/she must be able to link the movement to a series of reference points in space. Five levels were identified in the development of reference systems and the imaging of spatial movement (Levels I-V), which define visual imagery ability in children and illustrate greater ability with age. Other research is consistent with these findings (Dean, 1976; Wolff & Levin, 1972; Pressley & Levin, 1980). Recent research supports these developmental changes in which a relationship between visual movement imagery and kinesthesis appears to develop between the ages of 10 and 14 (Livesey, 2002). Contrary to these findings, results have demonstrated that 4-year-olds (Brody et al., 1978) and 5 and 6-year-olds (Ryan, Ledger & Weed, 1987) have been shown to exhibit visual imagery strategy if given extensive practice. Additional results conflict with the development of visual imagery ability as strictly related to age (Kosslyn et al., 1990; Borduin, Borduin, & Manley, 1993; Willoughby, et al., 1999). More information is needed to clarify this topic.

One of the components of imagery ability in adults and youth is an individual's experience with the physical activity imaged. According to psychoneuromuscular theory, electric activity in the muscles while imaging is similar to that while actually moving. It is possible that imaging may be facilitated by previous motor schemas already developed in an individual who has physical experience with the movement imaged. Furthermore, according to the symbolic learning theory, individuals who have prior motoric experience to draw upon are more likely to exhibit strong imagery abilities because the symbolic representation of a movement is already developed. Similarly, bioinformational theory asserts that as individuals gain physical experience they also gain responses to sport situations which are stored in memory. Consequently, imaging a desired performance is easier for them because they have more responses to reference.

Consistent throughout the literature investigating the effectiveness of imagery is the finding that physical practice facilitates performance to a greater degree than imagery rehearsal of the performance (Hird, Landers, Thomas, & Horan, 1991; Vealey & Greenleaf, 2001). Yet Hall, Rodgers and Barr (1990) concluded that imagery is effective in learning a skill when it is used in conjunction with physical practice. Engaging in activities which allow an individual to physically practice and experience a skill is critical to learning the components of a skill. Thus individuals who engage in physical activities regularly will have more information available to image these activities for performance enhancement later, and may have better developed imagery abilities.

In a specific study, (Hillman, Motl, Pontifex, Posthuma, Stubbe, Boomsma, & de Geus, 2006) the effects of physical activity on cognitive function were examined in adults and high school students. The results indicate that physical activity is associated with improved reaction time and response accuracy for this population. Therefore, if physical activity improves these aspects of cognitive function, then it is possible that it may have an influence on the cognitive processes of imagery ability as well. In another study, (Bird, 1984), EMG activity was recorded for 12-33 year-old athletes while imaging a movement. This EMG activity was congruent with the EMG activity recorded during actual execution of the movement. Bird (1984) also pointed out that the movement imaged was familiar to each of the participants. This follows with Weiss' (1991) evaluation of the psychological development of skills in children and adolescents which reports that the more knowledgeable children are about sport specific skills the stronger children's imagery abilities will be. This may be because adequate understanding of the physical and mental requirements needed to successfully execute a skill makes a child more likely to analyze and subsequently image the performance accurately.

Given these results, the purpose of this study was to investigate differences in the development of visual and kinesthetic imagery abilities by comparing these abilities in middle school age and high school age children. This was accomplished by examining differences between middle and high school students as measured by visual imagery ability and kinesthetic imagery ability. This study also examined whether physical activity has an influence on visual and kinesthetic imagery abilities at these ages.

It was hypothesized that middle school students would exhibit greater visual imagery ability than kinesthetic imagery ability while controlling for habitual physical activity and that high school students would exhibit greater visual and kinesthetic imagery abilities than middle school students while controlling for habitual physical activity. Furthermore, it was hypothesized that students with greater physical activity would exhibit greater imagery abilities than student with lower habitual physical activity.

METHODS

Participants

Male and female students were recruited from a charter school in the southeastern region of the United States were recruited to voluntarily participate. Ninety three middle school and 99 high school students volunteered. The middle school students (mean age

12.2 years, *SD* = .65) were enrolled in sixth or seventh grades when data was collected. The high school students (mean age 16.0 years, *SD* = .88) were enrolled in tenth or eleventh grades when data was collected.

Prior to collecting data, a parent/guardian consent form and assent form was distributed to all sixth, seventh, tenth and eleventh grade students while in school. The participants were given two weeks to discuss the forms with their legal guardians, sign and return them. Parent/Guardian permission was verified by comparing the signatures on the consent form with those on documentation submitted to the school earlier in the year from the Student-Parent handbook.

Instruments

Revised Movement Imagery Questionnaire (MIQ-R). Visual and kinesthetic imagery abilities were measured using the MIQ-R (Hall & Martin, 1997). It completed by all middle and high school participants. The MIQ-R was administered to assess the participants' abilities to use visual and kinesthetic imagery. The 8-item questionnaire was measured on a 7-point Likert scale (1 = very hard to image, 7 = very easy to image). Each of the 8 items involved a different movement, 4 of which the participants were asked to image visually and the remaining 4 kinesthetically. The questionnaire consisted of two subscales: visual imagery ability and kinesthetic imagery ability. The Movement Imagery Questionnaire (Hall & Pongrac, 1983) has a test-retest coefficient of .83 for a 1 week interval (Hall, Pongrac, & Buckolz 1985) and Atienza et al. (1994) reported internal consistencies for the visual (.89) and kinesthetic (.88) subscales. The MIQ-R which was used in the present study is significantly correlated with the MIQ on both subscales (Hall & Martin, 1997). The MIQ-R has been validated for children (Ille & Cadopi, 1999).

Baecke Questionnaire of Habitual Physical Activity (BQHPA). The BQHPA (Baecke, Burema & Fritjers, 1982) was used to estimate the participants' routine engagement in physical activity. The Baecke Questionnaire of Habitual Physical Activity (BQHPA) was originally developed to assess adult physical activity in work, sport and leisure time. The two subscales included in this study were physical activity in sports, and physical activity during leisure time. The BQHPA consisted of 13 items which were scored on a 5-point Likert scale (1 = Never, 5 = Always). The validity and reliability of the BQHPA has been previously reported (Philipaerts & Lefevre, 1998; Philippaerts, Westerterp, & Lefevre, 1999) and was used to assess physical activity in 12-18-year-olds in a previous study (Deforche, Lefevre, De Bourdeaudhuij, Hills, Duquet, & Bouckaert, 2003).

Procedure

The MIQ-R was administered by the researcher or research assistant in a semi-private location. The assistant was another teacher from the charter school. At no time did the researcher or research assistant administer the MIQ-R to a student enrolled in a course taught by that individual. A script of general instructions was read to each participant explaining the procedures of the MIQ-R. This script of instructions was also posted at the top of each participant's questionnaire. The researcher and/or assistant verbally described and physically modeled each movement before instructing the participant to produce the same movement. Once the participant completed the movement, the tester or assistant instructed him/her to kinesthetically or visually image the movement. Finally, the participant assessed his/her ability to feel or see the movement and indicated the level of ease for this mental task on the questionnaire.

The BQHPA was administered by the researcher and/or assistant during a regularly scheduled science class. The assistant was another teacher from the charter school. At no time did the researcher or research assistant administer the BQHPA to a student enrolled in a course taught by that individual. The researcher or assistant read a script explaining the general instructions for completing this questionnaire. This script was posted at the top of each participant's copy of the BQHPA. The participants were given twenty minutes to complete the questionnaires.

Design Analysis

The independent variable was the age group of the participants (middle school age or high school age) and the dependent variable was imagery ability (visual or kinesthetic). Habitual physical activity was examined as a covariate of visual and kinesthetic imagery abilities for all participants. The results of this study were analyzed using a 2x2 (age by imagery ability) mixed model ANCOVA with two subscales of habitual physical activity (participation in sports, physical activity during leisure time) as covariates. This was used to determine if the hypotheses would be accepted or rejected at the .05 alpha level. Data was analyzed using the statistical package for social sciences software (SPSS 12.0 for Windows, Student Version).

RESULTS

The MIQ-R was used to investigate the middle and high school participants' visual and kinesthetic imagery abilities. The BQHPA was used to investigate three components of the middle and high school participants' habitual physical activity. This included habitual physical activity in sport, and during leisure time. The purpose of this study was to investigate age differences (i.e. middle and high school participants) in visual and kinesthetic imagery abilities. Furthermore, this study investigated whether habitual physical activity has an influence on these imagery abilities. Prior to running statistical analyses to investigate these topics, the data was screened for outliers and tested for normality. Each of the MIQ-R subscales (visual imagery ability and kinesthetic imagery ability) and BQHPA subscales (physical activity in school, sport and leisure time) were also tested for reliability. Data collected from reliable subscales of the MIQ-R and BQHPA were analyzed and results are listed below. The reliability of each subscale was assessed using Cronbach's alpha. See table 2.

Hypothesis 1: Middle school students did not exhibit significant differences in visual and kinesthetic imagery abilities. A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between age group (i.e., middle school and high school) and type of imagery (i.e., visual and kinesthetic) while controlling for habitual physical activity in sport and during leisure time. The Age Group x Imagery Ability interaction ($F(1,188) = 1.689$, $p > .05$, $\eta^2_p = .009$) was not significant. The middle school age group did not differ in visual or kinesthetic imagery abilities.

Hypothesis 2: High school students also did not exhibit significant differences in visual and kinesthetic imagery abilities. A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between age group (i.e., middle school and high school) and type of imagery (i.e., visual and kinesthetic) while controlling for habitual physical activity in sport and during leisure time. The Age Group x Imagery Ability interaction ($F(1,188) = 1.689$, $p > .05$, $\eta^2_p = .009$) was not significant. The high school age group did not differ in visual or kinesthetic imagery abilities.

Hypothesis 3: High school students did not exhibit higher imagery abilities than middle school students. A 2 x 2 mixed model ANCOVA was calculated to examine differences in imagery ability between age group (i.e., middle school and high school) while controlling for habitual physical activity. The main effect for age group ($F(1,188) = .018$, $p > .05$, $\eta^2_p = .000$) was not significant. Imagery abilities did not differ between age groups.

Hypothesis 4: A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between type of imagery (i.e., visual and kinesthetic) and habitual physical activity in sport. The results indicate that a trend may exist. The Imagery Ability x Habitual Physical Activity in Sport interaction ($F(1,188) = 3.451$, $p = .065$, $\eta^2_p = .018$) was approaching significance. Students with greater habitual activity in sport exhibited moderately greater visual and kinesthetic imagery abilities than students with lower habitual activity in sport. Results are displayed in table 3 and figure 1.

Hypothesis 5: A 2 x 2 mixed model ANCOVA was calculated to examine interactions in imagery ability between type of imagery (i.e., visual and kinesthetic) and habitual physical activity during leisure time. There was not a significant interaction of imagery type by physical activity during leisure time ($F(1,188) = 1.689$, $p>.05$, $\eta^2_p = .009$). Students with greater habitual physical activity during free time did not exhibit differences in imagery abilities.

DISCUSSION

It was expected that the visual imagery ability scores of middle school students would be greater than their kinesthetic imagery ability scores because other findings indicate that visual imagery ability is greater than kinesthetic imagery ability at this age (Ille & Cadopi, 1999). In a comparison of the visual and kinesthetic imagery abilities of gymnasts in three age groups (8-9, 10-11 and 12-13), the visual imagery abilities were consistent across age groups and remained higher than kinesthetic for each. This indicates that the visual imagery processing components were already developed for these gymnasts and the authors report that age did not significantly influence visual imagery ability scores though it did influence their kinesthetic scores. The results of the current study conflict with this prior research as no significant difference was found between visual and kinesthetic imagery abilities.

A different line of research may explain these results. Livesey (2002) reported that a relationship exists between visual imagery ability and kinesthesis such that greater visual imagery ability is associated with greater kinesthetic acuity. The author concluded that this relationship develops between the ages of 10 and 14 (middle school age). If this relationship does exist for children in this age range, then middle school students may have a better-developed kinesthetic sense as a result. It follows that with a better-developed kinesthetic sense middle school students would be more likely to exhibit greater kinesthetic imagery abilities. It may be that this relationship reduces the gap between visual and kinesthetic imagery abilities as reported by Ille and Cadopi (1999); thus, explaining why there were no significant differences for the visual and kinesthetic imagery abilities of the participants in the present study. Based on these results, it can be concluded that kinesthetic imagery processing components may develop before a child reaches middle school age and may continue to develop while at middle school age. Thus, no significant differences in imagery abilities exist for the middle school students in the present study as they may have already developed both the visual and kinesthetic imagery processing components prior to reaching middle school age.

No significant difference was found for the visual and kinesthetic imagery abilities of the high school students. These results were expected because earlier research indicates that visual imagery abilities are generally greater than kinesthetic imagery abilities in late childhood and early adolescence (Ille & Cadopi, 1999) but not for college students (Féry, 2003). In a related investigation, Féry (2003) attempted to differentiate visual and kinesthetic imagery for college students (mean age = 21.9 years, SD = 3.1) by comparing the results of training (kinesthetic imagery, visual imagery or control) on their performance of a drawing task. The participants who underwent visual imagery training outperformed the other two groups in form reproduction, while the group who underwent kinesthetic imagery training outperformed the other groups in movement duration. Therefore the college students were capable of visually and kinesthetically imaging the movements, however they focused on different aspects of the movement while doing so. It is possible that high school participants of the present study exhibited no significant differences in their visual and kinesthetic imagery abilities because they were also focusing on different aspects of the MIQ-R movements.

Furthermore, one line of research points to age as an integral component to the development of imagery abilities (Piaget, Inhelder and Szeminska, 1960). Piaget and his colleagues identified 5 levels of imagery ability that are directly related to spatial awareness and therefore indirectly related to age. Later research investigating imagery abilities also reported significant differences in imagery abilities across age groups (Mwanalushi, 1974; Dean, 1976). For example, Kosslyn et al. (1990) expected marked differences in visual imagery ability with age; however, the results indicated that the sample did not exhibit increased visual imagery ability in increments but rather a marked polarity in visual imagery occurred across the age groups such that the two older groups and two younger groups were significantly different. The 14-year-olds, individuals of late middle school age, and adults produced visual mental images with similar ease and performed better than 5-year-olds and 8-year-olds.

These results are significant to the interpretation of the present study because the 14-year-olds (late middle school age) showed similar visual imagery abilities to adults; therefore, it is possible for middle school students to exhibit well-developed visual imagery ability according to these findings. Thus, it is expected that individuals belonging to an age group between middle school and adulthood (i.e. high school participants) would be likely to exhibit similar imagery abilities to the younger and older age group if those groups were similar to each other in these abilities. Kosslyn et al. (1990) concluded that there were not significant differences in the middle school age participants and adult participants because imagery processing components are developed by the age of five. The authors also concluded that these visual imagery processing components become more specialized with age which accounts for the differences in imagery abilities amongst the oldest and youngest age groups within that study. This may explain the results of the present study wherein no significant differences were found for middle and high school age groups because these visual imagery components are already developed and specialized.

The results of the present study also indicate that there were no significant differences in the kinesthetic imagery abilities of middle and high school participants

Contrary to these findings, past research has shown that visual imagery ability appears to develop before kinesthetic imagery ability (Ille & Cadopi, 1999). These authors conclude that when comparing three age groups (8-9, 10-11 and 12-13) visual imagery ability was higher then kinesthetic for each age group and the highest kinesthetic imagery abilities were reported for the oldest age group of less-skilled gymnasts, who were of middle school age. Given these results, the development of kinesthetic imagery processing may take place prior to or during the first year of middle school. This suggests that no significant difference would be reported for the kinesthetic imagery abilities of the middle and high school students because both age groups have already developed and specialized kinesthetic imagery processing components.

When interpreting the results of data collected with a questionnaire it is also important to evaluate the measurement being used. The measurement utilized in this study was the MIQ-R. Variations of the MIQ-R have been used with participants of middle school age in earlier research (Ille & Cadopi, 1999; Livesey, 2002). Even when using reliable questionnaires which have been validated such as the MIQ-R, it is necessary to assume that the questions and scale are understood by the participants with any sample population. Livesey (2002) reported that using questionnaires with children can be problematic because there is the possibility that children will misunderstand the terms of the questionnaire despite offering extensive verbal and written instruction. Though similar instructions were given to all participants of the present study, they may have been unclear for some. It may be that the MIQ-R was misinterpreted by some of the participants and consequently the data collected may not accurately reflect the participants' imagery abilities. We recommend that a new instrument should be created to assess the visual and kinesthetic imagery abilities of children.

The results of this student indicate that a trend may exists such that students who participate in sport more frequently then their peers may possess greater visual and kinesthetic imagery abilities. In a study investigating the visual and kinesthetic imagery abilities of gymnasts, the authors found that the kinesthetic imagery ability of the gymnasts was significantly affected by skill level (Ille & Cadopi, 1999). Mumford and Hall (1985) also report that kinesthetic imagery ability is affected by skill level for figure skaters. Given those results, it is possible that an individual with greater participation in sport may also possess higher skill levels, and consequently greater kinesthetic imagery abilities. The present study did not investigate skill level as a component of imagery but did hypothesize that participation in sport would be associated with greater imagery abilities.

Alternatively, Ille and Cadopi (1999) and Mumford and Hall (1985) reported that skill level did not significantly influence visual imagery ability. This may be due to the fact that processing components were already developed for those participants; therefore, their visual imagery ability scores were greater. The results of the present study may conflict with those findings because the interaction between the students' participation in sport and visual imagery score was approaching significance. More information is needed on this topic. Furthermore, it is important to consider that responses to self-report measures can be highly variable and that children are a unique sample population as well. Consequently, further investigation of this topic is merited as the self-report measures completed by children in the present study yield results which indicate that a trend exists.

No significant interaction was found for physical activity during leisure time and kinesthetic imagery ability. Additionally, no significant interaction was also found for physical activity in sport and visual imagery ability either. These results are unexpected given that a trend may exists for middle and high school students such that those students with greater habitual physical activity in sport and may also have greater imagery abilities. It was expected that greater physical activity in leisure time would yield results similar to those of greater participation in sport because physical activity in general has been shown to influence imagery abilities in adults (Ozel, Larue, & Molinaro, 2004) and middle and high school students have been shown to exhibit similar physiological activity to adults while imaging (Bird, 1984). Physical activity in general may have an effect on the imagery abilities of middle and high school students regardless of the when this physical activity occurs. More information is needed on this topic.

The results of this study do not indicate that such an interaction exists between physical activity during leisure time and imagery abilities. This may be due to the instrument being used to collect data. In the original form of the BQHPA, questions 7-13 belong to the leisure time subscale; however, the word “free” was substituted for the word “leisure” to eliminate confusion for the participants. It is possible that the participants still had a difficult time conceptualizing and accurately rating their physical activity during leisure activities, and may have interpreted “free time” as parts of the day when they were permitted to rest or relax. If this did occur, then the participants would have underestimated their physical activity during leisure time and consequently an interaction is not reported.

REFERENCES

American Heart Association. Children's Need for Physical Activity: Fact Sheet. Retrieved October 15, 2006, from http://www.americanheart.org/presenter.jhtml?identifier=771

Atienza, F., Balaguer, I., & Garcia-Merita, M. L. (1994). Factor analysis and reliability of the Movement Imagery Questionnaire. Perceptual Motor Skills, 78 (3-2), 1323-1328.

Baecke, J. A. H., Burema, J., & Fritjers, J. E. R. (1982). A short questionnaire for the measurement of habitual physical activity in epidemiological studies. American Journal of Clinical Nutrition, 36 (5), 936-942.

Bird, E. (1984). EMG quantification of mental rehearsal. *Perceptual and Motor Skills, 59,* 899-906.

Borduin, B., Borduin, C., & Manley, C. M. (1993). The use of imagery training to improve reading comprehension of second graders. *The Journal of Genetic Psychology, 155*(1), 115-118.

Brody**,** G. H., Mattson**,** S. L., & Zuckerwise**,** B. L. (1978). Imagery induction in preschool children: An examination of subject and experimenter generated interactions. *Journal of Genetic Psychology, 132*(2), 307-311.

Dean, A. L. (1976) The structure of imagery. *Child Development, 47*(4), 949-958.

Deforche, B., Lefevre, J., De Bourdeauhuij, I., Hills, A. P., Duquet, W., & Bouckaert, J. (2003). Physical Fitness and Physical Activity in Obese and Nonobese Flemish Youth. *Obesity Research*, *11 (3)*, 434-441.

Féry, Y. (2003). Differentiating visual and kinesthetic imagery in mental practice. *Canadian Journal of Experimental Psychology, 57*(1), 1-10.

Hall, C. R., Mack, D. E., Paivio, A., & Hausenblaus, H. A. (1998). Imagery use by athletes: Development of the sport imagery questionnaire. *International Journal of Sport Psychology, 29,* 73-89.

Hall, C. R., & Martin, K. A. (1997). Measuring movement imagery abilities: A revision of the Movement Imagery Questionnaire. *Journal of Mental Imagery, 21 (1-2),* 143-154.

Hall, C. R., & Pongrac, A. (1983). *Movement Imagery Questionnaire*. Ontario, Canada: Western Ontario University.

Hall, C. R., Pongrac, A., & Buckolz, E. (1985). The measurement of imagery ability. *Human Movement Science, 4,* 107-118.

Hall, C. R., & Rodgers, W. M. (1989). Enhancing coaching effectiveness in figure skating through a mental skills training program. *The Sport Psychologist, 2,* 142-154.

Hall, C. R., & Rodgers, W. M., Barr, K. A. (1990). The use of imagery by athletes in selected sports. *The Sport Psychologist, 4,* 1-10.

Hall, C. R., Schmidt, D., Durant, M., & Buckolz, E. (1994). Imagery and motor skills acquisition. In A. A. Sheik & E. R. Korn (Eds.), *Imagery in Sports and Physical Performance* (pp. 121-134). Amityville, N.Y.: Baywood Publishing Company.

Hillman, C. H., Motl, R. W., Pontifex, M. B., Posthuma, D., Stubbe, J. H., Boomsma, D. I., & de Geus, E. J. C., (2006). Physical Activity and Cognitive Function in a

Cross-Section of Younger and Older Community-Dwelling Individuals. *Health Psychology, 25*(6), 678-687.

Hird, J. S., Landers, D. M., Thomas, J. R., & Horan, J. J. (1991). Physical practice is superior to mental practice in enhancing cognitive and motor task performance. *Journal of Sport & Exercise Performance, 13,* 281-293.

Hoffman**,** C. D., Hawkins**,** W. (1980). The effects of pretraining on children's recognition memory for pictures. *Journal of Genetic Psychology, 137*(2), 301-302.

Ille, A., & Cadopi, M. (1999) Memory for movement sequences in gymnastics: Effects of age and skill level. *Journal of Motor Behavior, 31*, 290-300.

Kosslyn, S. M., Margolis, J. A., Barrett, A. M., Goldknopf, E. J., & Daly, P. F. (1990). Age differences in imagery abilities. *Child Development, 61,* 995-1010.

Livesey, D.J. & Kangas, M. (1997). The role of visual movement imagery in kinaesthetic sensitivity and motor performance. *The Australian Educational and Developmental Psychologist, 14* (1), 2 - 10.

Livesey, D. J. (2002). Age differences in the relationship between visual movement imagery and performance on kinesthetic acuity tests. *Developmental Psychology, 38*(2), 279-287.

Mahoney, M. J., & Avener, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive Therapy and Research, 1*, 135-141.

Martin, K. A., Mortiz, S. E., & Hall, C. R. (1999). Imagery use in sport; A literature review and applied model. *The Sport Psychologist, 13,* 245-268.

Mumford, B., & Hall, C. (1985). The effects of internal and external imagery on performing figures in figure skating. *Canadian Journal of Applied Sport Sciences*, 10(4), 171-177.

Mwanalushi, M. (1974). Imaginal factors in the coding of random patterns by children. *Child Development, 45*, 204-207.

Overby**,** L. Y. (1990). A comparison of novice and experienced dancers' imagery ability. *Journal of Mental Imagery,14*(3-4), 173-184.

Ozel, S., Larue, J., & Molinaro, C. (2004). Relation between sport and spatial imagery; comparison of three groups of participants. *The Journal of Psychology, 138*, 49-63.

Paivio, A. (1971). *Imagery and Verbal Processes*. New York: Holt, Rinehart and Winston.

Paivio, A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Sciences*, *10*, 225-285.

Philippaerts, R. M., & Lefevre, J. (1999). Reliability and validity of three activity questionnaires in Flemish males. *American Journal of Epidemiology*, *147,* 982-990.

Philippaerts, R. M., Westerterp, K. R., & Lefevre, J. (1999). Doubly labeled water validation of three physical activity questionnaires. *International Journal of Sports Medicine*, *20,* 284-289.

Piaget, J. (1970). Piaget's theory. In P. H. Mussen (Ed.), *Carmichael's manual of child psychology,* (3rd edition). New York: Wiley.

Piaget, J., Inhelder, B., & Szeminska, A. (1960). *The Child's Conception of Geometry.* New York: Harper & Row.

Pressley, M., Johnson, C. J., Symons, S., McGoldrick, J. A., & Kurita, H. (1989). Strategies that improve children's memory and comprehension of text. *Elementary School Journal, 90*(1), 3-32.

Pressley, M., & Levin**,** J. R. (1980) The development of mental imagery retrieval. *Child Development, 51*(2), 558-560.

Ryan, E. B., Ledger, G. W., & Weed, K. A. (1987). Acquisition and transfer of an integrative imagery strategy by young children. *Child Development, 58*, 443-452.

Varley, W. H., Levin**,** J. R., Severson**,** R. A., & Wolff, P. (1974). Training imagery production in young children through motor involvement. *Journal of Educational Psychology, 66*(2), 262-266.

Vealey, R. S. (1986). Conceptualization of sport confidence and competitive orientation; Preliminary investigation and instrument development. *Journal of Sport Psychology, 8,* 221-246.

Vealey, R. S., & Greenleaf, C. A. (2001). Seeing is believing: Understanding and using imagery in sport. In J. M. Williams (Ed.), *Applied Sport Psychology: Personal growth to peak performance* (pp. 247-272). Mountain View, CA: Mayfield Publishing Company.

Vealey, R. S., & Walter, S. M. (1993). Imagery training for performance enhancement and personal development. In J. M. Williams (Ed.) *Applied Sport Psychology: Personal growth to peak performance* (2nd ed., pp. 200-224). Mountain View, CA: Mayfield.

Weiss, M. R. (1991). Psychological skill development in children and adolescents. *The Sport Psychologist, 5*, 335-354.

Willoughby, T., Porter, L., Belsito, L. (1999). Use of elaboration strategies by students in grades two, four and six. *Elementary School Journal*, *99*(3), 221-231.

Wolff, P., & Levin, J. R. (1972). The role of overt activity in children's imagery production. *Child Development*, *43*(2), 537-547.

Wrisberg, R. L., & Anshel, M. H. (1989). The effect of cognitive strategies on the free throw shooting performance of young athletes. *The Sport Psychologist, 3*, 95-104.

Younis, J., & Dean, A. (1974). Judgement and imaging aspects of operations: a Piagetian study with Korean and Costa Rican children. *Child Development*, *45*, 1020-1031.

Table 1: Descriptive Statistics for Converted Means of MIQ-R and BQHPA Subscales by Age Group

AgeGroup		KIA Trans.	VIA Trans.	Phys. Act. School	Phys. Act. Sport	Phys. Act. Leisure
Middle School	Mean	1.3840	1.3349	3.1742	3.0903	3.0584
	N	93	93	93	93	93
	Std. Deviation	.24715	.23929	.40025	1.26886	.62171
High School	Mean	1.4167	1.3155	3.0303	2.9737	3.1371
	N	99	99	99	99	99
	Std. Deviation	.27284	.29344	.43176	1.24364	.64888
Total	Mean	1.4009	1.3249	3.1000	3.0302	3.0990
	N	192	192	192	192	192
	Std. Deviation	.26055	.26806	.42191	1.25399	.63543

Table 2: Reliability of MIQ-R and BQHPA Subscales.

Subscale	**Cronbach's alpha**
Kinesthetic Imagery Ability (KIA)	.688
Visual Imagery Ability (VIA)	.740
Physical Activity in Sport	.863
Physical Activity During Leisure Time	.704

Table 3: Descriptive Statistics for the Imagery Abilities of Students Grouped by High and Low Levels of Habitual Physical Activity in Sport

Phys. Act. Sport		KIA Transf.	VIA Transf.
Low	Mean	1.4218	1.3388
	N	102	102
	Std. Deviation	.26886	.27551
High	Mean	1.3771	1.3091
	N	90	90
	Std. Deviation	.25018	.25998
Total	Mean	1.4009	1.3249
	N	192	192
	Std. Deviation	.26055	.26806

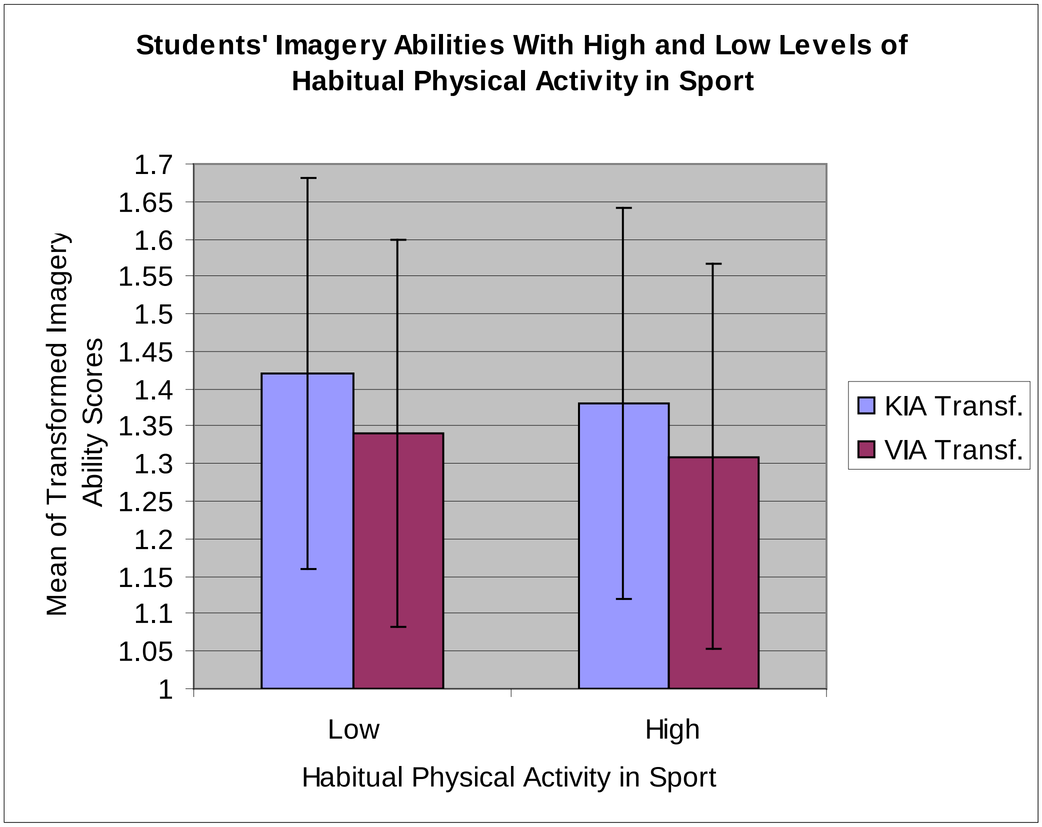

Figure 1: Transformed Visual and Kinesthetic Imagery Abilities Scores of Students with High and Low Levels of Habitual Physical Activity in Sport

Appendix B

Movement Imagery Questionnaire Revised Test Items

1. **STARTING POSITION:** Stand with your feet and legs together and your arms at your sides.

   ACTION: Raise your right knee as high as possible so that you are standing on your left leg with your right leg flexed (bent) at the knee. Now lower your right leg so that you are again standing on two feet. Perform these actions slowly.

   MENTAL TASK: Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

2. **STARTING POSITION:** Stand with your feet slightly apart and your hands at your sides.

   ACTION: Bend down low and then jump straight up in the air as high as possible with both arms extended above the head. Land with your feet apart and lower your arms to your sides.

   MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

3. **STARTING POSITION:** Extend the arm of your nondominant hand straight out to your side so that it is parallel to the ground, palm down.

   ACTION: Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.

   MENTAL TASK: Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

4. **STARTING POSITION:** Stand with your feet slightly apart and your arms fully extended above your head.

   ACTION: Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head.

MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

5. **STARTING POSITION:** Stand with your feet slightly apart and your hands at your sides.
ACTION: Bend down low and then jump straight up into the air as high as possible with both arms extended above the head. Land with your feet apart and lower your hands to your sides.

MENTAL TASK: Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

6. **STARTING POSITION:** Stand with your feet and legs together and your arms at your sides.

ACTION: Raise your right knee as high as possible so that you are standing on two feet. Perform these actions slowly.

MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

7. **STARTING POSITION:** Stand with your feet slightly apart and your arms fully extended above your head.

ACTION: Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head.

MENTAL TASK: Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

8. **STARTING POSITION:** Extend the arm of your non dominant hand straight out to your side so that it is parallel to the ground, palm down.

ACTION: Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.

MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

Appendix B

Extra Credit Questionnaire 1

Name:_______________________		Circle One: Male Female
Age: __________	Birthday:_________	Grade: _________

Directions:

Watch the guide perform a movement.
When told to do so, you perform the movement.
Then the guide will tell you to close your eyes and imagine feeling or seeing the movement.
Write down how easy it was to feel or see the movement according to this scale:

7	6	5	4	3	2	1
Very easy to feel or see	Easy to feel or see	Somewhat easy to feel or see	Neutral (Not easy, not hard)	Somewhat hard to feel or see	Hard to feel or see	Very hard to feel or see

Movement #1: How easy to feel? _______
Movement #2: How easy to see? _______
Movement #3: How easy to feel? _______
Movement #4: How easy to see? _______
Movement #5: How easy to feel? _______
Movement #6: How easy to see? _______
Movement #7: How easy to feel? _______
Movement #8: How easy to see? _______

Appendix C

Extra Credit Questionnaire (Part 2)

Name: ______________________ Grade:_________

Circle One: Male Female Age: _____ Birthday: _________

Directions: Read each of the questions below and think about an average day. Then circle the answer which best fits your response.

Don't write in this box!

1) While at school I sit:

never rarely sometimes often always

1 2 3 4 5

2) While at school I stand:

never rarely sometimes often always

1 2 3 4 5

3) While at school I walk:

never rarely sometimes often always

1 2 3 4 5

4) While at school I carry heavy things:

always often sometimes rarely never

5 4 3 2 1

5) After school I am tired:

1 2 3 4 5

never rarely sometimes often always

6) Do you play a sport: Yes No

If yes, which sport do you play the most? ___________________

How many hours per week? Less than 1 1-2 2-3 3-4 Over 4

How many months per year? Less than 1 1-2 2-3 3-4 Over 4

If you play a second sport, what is it? __________________

How many hours per week? Less than 1 1-2 2-3 3-4 Over 4

How many months per year? Less than 1 1-2 2-3 3-4 Over 4

Appendix C

7) Compared to other kids my age, I think my free time is:

much more physically active	more physically active	about the same as others	less physically active	much less physically active

8) During my free time I sweat:

very often often sometimes rarely never

9) During my free time I play a sport:

never rarely sometimes often always

10) During my free time I watch T.V. or play video games:

never rarely sometimes often always

11) During my free time I walk:

never rarely sometimes often always

12) During my free time I ride a bike OR run:

never rarely sometimes often always

13) During the week and weekends, I walk or ride a bike to get around:

never rarely sometimes often always

Don't write in this box!

5 4 3 2 1

5 4 3 2 1

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

1 2 3 4 5

Sch:

Sp:

FT:

Appendix D

Barry University Parent Consent Form

Your participation in a research project is requested. The title of the study is *Differences in Visual and Kinesthetic Imagery Abilities as Controlled by Habitual Physical Activity in Middle and High School Students*. The research is being conducted by Candice Franco, a teacher at Doctors Charter School and a graduate student in the School of Human Performance and Leisure Science at Barry University. The aim of the research is to investigate the relationship between age, imagery abilities and habitual physical activity levels. In accordance with these aims, you will complete two questionnaires that will be distributed and collected by Ms. Franco or Mr. Morales (Personal Fitness teacher at Doctors Charter School) at another time. These questionnaires will be **confidential,** which means that you will write your name on the questionnaire however only Miss Franco or Mr. Morales will see your responses. It is estimated that 200 students will participate.

If your parent/guardian gives consent for you to participate, you will be asked to complete two confidential surveys. The Revised Movement Imagery Questionnaire will assess your ability to imagine seeing or feeling themselves perform a movement. The Baecke Questionnaire of Habitual Physical Activity will assess how much physical activity you do in a typical week. Participants will submit their confidential, written responses to Ms. Franco or Mr. Morales. It is estimated that completing both confidential questionnaires will take less then 15 minutes total.

There are no known risks to you should you decide to participate in the study. As a research participant, information you provide will be held in confidence to the extent permitted by law. Any published results of the research will refer to group averages only. Information you provide will be kept in a locked file off of Doctor's Charter School campus and destroyed after 5 years. Consent forms will be stored separately from the questionnaires in a locked file off campus. Consent for your participation is strictly voluntary and if your parent/guardian declines consent or should you choose to drop out at any time during the study, there will be no adverse effect on your grades. If you decide to participate, you will earn extra credit in one class. You can refuse to participate and still earn extra credit by completing another project in which you will read an article on global warming and answer a question set about this topic. It is estimated that this alternative will take you less then 15 minutes to complete.

If you have any questions or concerns regarding the study you may contact me, Candice Franco, at (305) 299-9275 or francoc@doctorscharterschool.org, my supervising professor, Dr. Gualberto Cremades, at (305) 899-4846, or the Institutional Review Board point of contact, Ms. Nildy Polanco, at (305) 899-3020. If your parent/guardian gives permission for you to participate, he/she must indicate this by signing this consent form. If you are willing to participate in this research you and your parent/guardian must sign the attached assent form also. Please return both forms by Friday, February ??, 2007.

Voluntary Consent

I acknowledge that I have been informed of the nature and purpose of this study by

Ms. Candice Franco. I have read and understand the information presented above and retained a copy of this form for my records. **I give voluntary consent for my child to participate in this study.**

______________________________ __________

Signature of Parent/Guardian *Date*

______________________________ __________

Signature of Researcher *Date*

Appendix D

Barry University Parent Consent Form

Your child's participation in a research project is requested. The title of the study is *Differences in Visual and Kinesthetic Imagery Abilities as Controlled by Habitual Physical Activity in Middle and High School Students*. The research is being conducted by Candice Franco, a teacher at Doctors Charter School and a graduate student in the School of Human Performance and Leisure Science at Barry University. The aim of the research is to investigate the relationship between age, imagery abilities and habitual physical activity levels. In accordance with these aims, your child will complete two questionnaires that will be distributed and collected by Ms. Franco or Mr. Morales (Personal Fitness teacher at Doctors Charter School) at a time to be determined. These questionnaires will be **confidential,** which means that participants will write identifying information on the questionnaire however only Miss Franco or Mr. Morales will see the responses. Information provided by each research participant will be kept in a locked file off of Doctor's Charter School campus and destroyed after 5 years. It is estimated that the number of participants will be 200.

If you give consent for your child to participate, he/she will be asked to complete two confidential surveys. The Revised Movement Imagery Questionnaire will assess your child's ability to imagine seeing or feeling themselves perform a movement. The Baecke Questionnaire of Habitual Physical Activity will assess how much time your child spends doing physical activity throughout a typical week. The participants will submit their confidential, written responses to Ms. Franco or Mr. Morales. It is estimated that completing both confidential questionnaires will take less then 15 minutes total.

There are no known risks to your child should you decide to allow him/her to participate in the study. Consent for your child to participate is strictly voluntary and should you decline consent or should your child choose to drop out at any time during the study, there will be no adverse effects to your child's grades. Should you give consent for your child to participate in this optional activity, your child will earn extra credit in one class. Your child can refuse to participate and still earn extra credit by completing an alternative assignment about global warming.

If you have any questions or concerns regarding the study or your child's participation in the study, you may contact me, Candice Franco, at (305) 299-9275 or francoc@doctorscharterschool.org, my supervising professor, Dr. Gualberto Cremades, at (305) 899-4846, or the Institutional Review Board point of contact, Ms. Nildy Polanco, at (305) 899-3020. If you are satisfied with the information provided and are willing to given permission for your child to participate in this research please sign this consent form and the attached assent form. Please return both forms by Friday, February ??, 2007.

Voluntary Consent

I acknowledge that I have been informed of the nature and purpose of this study by Ms. Candice Franco. I have read and understand the information presented above and retained a copy of this form for my records. I give voluntary consent for my child to participate in this study.

________________________________ __________
Signature of Parent/Guardian *Date*

________________________________ __________
Signature of Researcher *Date*

Appendix E

Barry University

ASSENT FORM INVOLVING MINORS

Assent for Children

The age of majority in Florida is 18. For subjects under 18 years of age, consent must be obtained from the parent or court-appointed legal guardian. In addition, the Institutional Review Board requires assent from children aged 7-17. The following assent statement should be included with the parental consent form.

We are doing a research study that includes children such as you. This study is called "Differences in Visual and Kinesthetic Imagery Abilities as Controlled by Habitual Physical Activity in Middle and High School Students". We have explained the study to you, and we need to know whether you are willing to participate. Please sign your name below so that we can be certain whether you want to be in the study or not. Thank you.

____ I am willing

____ I am not willing

to participate in the research study which has been explained to me by

___________________________________ ___________________

Signature of Researcher *Date*

___________________________________ ___________________

Signature of Child *Date*

___________________________________ ___________________

Signature of Parent *Date*

REFERENCES

Abma, C. L., Fry, M. D., Li, Y., & Relyea, G. (2002). Differences in Imagery Content and Imagery Ability Between High and Low Confident Track and Field Athletes. *Journal of Applied Sport Psychology, 14,* 67-75.

American Heart Association. *Children's Need for Physical Activity: Fact Sheet.* Retrieved October 15, 2006, from http://www.americanheart.org/presenter.jhtml?identifier=771

Atienza, F., Balaguer, I., & Garcia-Merita, M. L. (1994). Factor analysis and reliability of the Movement Imagery Questionnaire. *Perceptual Motor Skills, 78 (3-2),* 1323-1328.

Baecke, J. A. H., Burema, J., & Fritjers, J. E. R. (1982). A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *American Journal of Clinical Nutrition, 36 (5),* 936-942.

Bakker, F. C., Boschker, M. S., & Chung, T. (1996). Changes in muscular activity while imaging weight-lifting using stimulus or response propositions. *Journal of Sport and Exercise Psychology, 18,* 313-324.

Beauchamp, P. H., Halliwell, W. R., Fournier, J. F., & Koestner, R. (1996). Effects of cognitive-behavioral psychological skills training on the motivation, preparation, and putting performance of novice golfers. *The Sport Psychologist, 10,* 157-170.

Bender, B. G., & Levin, J. R. (1976). Motor activity, anticipated motor activity, and young children’s associative learning. *Child Development, 47*, 560-562.

Bird, E. (1984). EMG quantification of mental rehearsal. *Perceptual and Motor Skills, 59,* 899-906.

Borduin, B., Borduin, C., & Manley, C. M. (1993). The use of imagery training to improve reading comprehension of second graders. *The Journal of Genetic Psychology, 155*(1), 115-118.

Brody**,** G. H., Mattson**,** S. L., & Zuckerwise**,** B. L. (1978). Imagery induction in preschool children: An examination of subject and experimenter generated interactions. *Journal of Genetic Psychology, 132*(2), 307-311.

Bull**,** B. L., & Wittrock**,** M. C. (1998). Imagery in the learning of verbal definitions. *British Journal of Educational Psychology, 43*(3), 289-293.

Burhans, R. S., Richman, C. L., & Bergey, D. B. (1988). Mental imagery training: Effects on running speed performance. *International Journal of Sport Psychology, 19*(1), 26-37.

Callow, N. & Hardy, L. (2001). Types of imagery associated with sport confidence in netball players of varying skill levels. *Journal of Applied Sport Psychology, 13,* 1-17.

Callow, N., Hardy, L., & Hall, C. (1998). The effect of a motivational-mastery imagery intervention on the sport confidence of three elite badminton players. *Journal of Applied Sport Psychology, 10*.

Callow, N., & Waters**,** A. (2005). The effect of kinesthetic imagery on the sport confidence of flat-race horse jockeys. *Psychology of Sport and Exercise, 6*(4), 443-459.

Calopi, M., & D'Arripe-Longueville, F. (1998). Relations between mental imagery and sporting performance. In P. Fleurance (Ed.), Entraînement mental et sport de haute performance. *Les cahiers de l'Insep*, 165-193.

Chapman, C., Lane, A. M., Brierley, J. H., & Terry, P. C. (1997). Anxiety, self-confidence and performance in Tae Kwon-Do. *Perceptual Motor Skills, 85,* 1275-8.

Cogan, K. D., & Petrie, T. A. (1995). Sport consultation: An evaluation of a season-long intervention with female collegiate gymnasts. *The Sport Psychologist*, 9, 282-296.

Corbin, C. B. (1972). Mental practice. In W. P. Morgan (Ed.), *Erogonic aids and muscular performance* (pp. 94-118). New York: Academic Press.

Cox, R. H. (2002). *Sport Psychology: Concepts and Applications.* Madison: Brown & Benchmark Publishers.

Dean, A. L. (1976) The structure of imagery. *Child Development*, *47*(4), 949-958.

Decety, J., & Ingvar, D. H. (1990). Brain structures participating in mental simulation of motor behavior: A neuropsychological interpretation. *Acta Psychologica, 73*(1), 13-34.

Decety, J., Jeannerod, M., Germain, M., & Pastene, J. (1991). Vegetative response during imagined movement is proportional to mental effort. *Behavioural Brain Research, 42,* 1-5.

Decety, J., Jeannerod, M., Durozard, D., & Baverel, G. (1993). Central activation of autonomic efforts during mental simulation of motor effort. *Journal of Physiology, 461,* 549-563.

Deforche, B., Lefevre, J., De Bourdeauhuij, I., Hills, A. P., Duquet, W., & Bouckaert, J. (2003). Physical Fitness and Physical Activity in Obese and Nonobese Flemish Youth. *Obesity Research, 11 (3),* 434-441.

Doheny**,** M. O. (1993). Effects of mental practice on performance of a psychomotor skill. *Journal of Mental Imagery, 17*(3-4), 111-118.

Driskell, J. E., Copper, C., & Moran, A. (1994). Does mental practice enhance performance? *Journal of Applied Psychology, 79,* 481-491.

Gallego, J., Denot-Ledunois, S., Vardon, G., & Perruchet, P. (1996). Ventilatory responses to imagined exercise. *Psychophysiology, 33,* 711-719.

Garza, D. L., & Feltz, D. L. (1998). Effects of selected mental practice on performance, self-efficacy and competition confidence of figure skaters. *The Sport Psychologist, 12*, 1-15.

González, M. A., Campos, A., & Pérez, M. J. (1997). Mental imagery and creative thinking. *The Journal of Psychology, 131*(4), 357-364.

Feltz, D. L. & Landers, D. M. (1983). The effects of mental practice on motor skill learning and performance: a meta-analysis. *Journal of Psychology, 5*, 25-27.

Feltz, D. L., Landers, D. M., & Becker, B. J. (1988). A revised meta-analysis of the mental practice literature on motor skill learning. In D. Druckman & J. Swets (Eds.) *Enhancing human performance: Issues, theories and techniques* (pp.1-65). Washington, D. C.: Academy Press.

Fenker, R. M., & Lambiotte, J. G. (1987). A performance enhancement program for a college football team: One incredible season. *The Sport Psychologist, 1,* 224-236.

Féry, Y. (2003). Differentiating visual and kinesthetic imagery in mental practice. *Canadian Journal of Experimental Psychology, 57*(1), 1-10.

Fischer, A. C. (1986). *Imagery from a sport psychology perspective.* Paper presented at the meeting of the American Alliance for Health, Physical Education, Recreation and Dance, Cincinnati, Ohio.

Hale, B. D. (1982). The effects of internal and external imagery on muscular and ocular concomitants. *Journal of Sport Psychology, 4,* 379-387.

Hale, B. D., & Whitehouse, A. (1998). The effects of imagery-manipulated appraisal on intensity and direction of competitive anxiety. *The Sport Psychologist*, *12,* 40-51.

Hall, E. G., & Erffmeyer, E. S. (1983). The effect of visuo-motor behavior rehearsal with videotaped modeling on free throw accuracy of intercollegiate female basketball players. *Journal of Sport Psychology, 5,* 343-346.

Hall, C. R., Mack, D. E., Paivio, A., & Hausenblaus, H. A. (1998). Imagery use by athletes: Development of the sport imagery questionnaire. *International Journal of Sport Psychology, 29,* 73-89.

Hall, C. R., & Martin, K. A. (1997). Measuring movement imagery abilities: A revision of the Movement Imagery Questionnaire. *Journal of Mental Imagery, 21 (1-2),* 143-154.

Hall, C. R., & Pongrac, A. (1983). *Movement Imagery Questionnaire*. Ontario, Canada: Western Ontario University.

Hall, C. R., Pongrac, A., & Buckolz, E. (1985). The measurement of imagery ability. *Human Movement Science, 4,* 107-118.

Hall, C. R., & Rodgers, W. M. (1989). Enhancing coaching effectiveness in figure skating through a mental skills training program. *The Sport Psychologist*, *2*, 142-154.

Hall, C. R., & Rodgers, W. M., Barr, K. A. (1990). The use of imagery by athletes in selected sports. *The Sport Psychologist, 4,* 1-10.

Hall, C. R., Schmidt, D., Durant, M., & Buckolz, E. (1994). Imagery and motor skills acquisition. In A. A. Sheik & E. R. Korn (Eds.), *Imagery in Sports and Physical Performance* (pp. 121-134). Amityville, N.Y.: Baywood Publishing Company.

Hanrahan, C., Salmela, J. H. (1990). Dance Images--Do They Really Work or Are We Just Imagining Things? *Journal of Physical Education, Recreation & Dance, 61*.

Hardy, L. (1997). Three myths about applied consultancy work. *Journal of Applied Sport Psychology, 9,* 277-294.

Harris, D. V., & Robinson, W. J. (1986). The effects of skill level on EMG activity during internal and external imagery. *Journal of Sport Psychology, 11,* 290-298.

Hashimoto, R., & Rothwell, J. C. (1999). Dynamic changes in corticospinal excitability during motor imagery. *Experimental Brain Research*, *125,* 75-81.

Hillman, C. H., Motl, R. W., Pontifex, M. B., Posthuma, D., Stubbe, J. H., Boomsma, D. I., & de Geus, E. J. C., (2006). Physical Activity and Cognitive Function in a Cross-Section of Younger and Older Community-Dwelling Individuals. *Health Psychology, 25*(6), 678-687.

Hird, J. S., Landers, D. M., Thomas, J. R., & Horan, J. J. (1991). Physical practice is superior to mental practice in enhancing cognitive and motor task performance. *Journal of Sport & Exercise Performance, 13,* 281-293.

Hoffman, C. D., Hawkins, W. (1980). The effects of pretraining on children's recognition memory for pictures. *Journal of Genetic Psychology, 137*(2), 301-302.

Hollenberg, C. K. (1970). Functions of visual imagery in the learning and concept formation of children. *Child Development, 41*(4), 1003-1015.

Ille, A., & Cadopi, M. (1999) Memory for movement sequences in gymnastics: Effects of age and skill level. *Journal of Motor Behavior, 31*, 290-300.

Ingvar, D. H., & Philipson, L. (1977). Distribution of cerebral blood flow in the dominant hemisphere during motor ideation and motor performance. *Annals of Neurology, 2*, 230-237.

Isaac, A. R., & Marks, D. F. (1994). Individual differences in mental imagery experiences: Developmental changes and specialization. *British Journal of Psychology, 85,* 479-500.

Jacobson, E. (1931). Electrical measurement of neuromuscular states during mental activities. *American Journal of Physiology, 96,* 115-121.

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral Brain Sciences, 17,* 187-243.

Jowdy, D. P., & Harris, D. V. (1990). Muscular responses during mental imagery as a function of motor skill level. *Journal of Sport & Exercise Psychology, 12,* 191-201.

Kerr, G., & Leith, L. (1993). Stress management and athletic performance. *The Sport Psychologist, 1,* 221-231.

Kosslyn, S. M., Margolis, J. A., Barrett, A. M., Goldknopf, E. J., & Daly, P. F. (1990). Age differences in imagery abilities. *Child Development, 61*, 995-1010.

Kulhavy, R. W., Canaday, J. O., Haynes, C. R., & Schallert, D. L. (1977). Mnemonic transformations and verbal coding processes in children. *Journal of General Psychology, 96*(2), 209-215.

Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology, 16,* 495-512.

Lang, P. J., Melamed, B. G., & Hart, J. A. (1970). A psychophysiological analysis of fer modification using an automated desensitization procedure. *Journal of Abnormal Psychology, 76,* 229-234.

Lee, C. (1990). Psyching up for a muscular endurance task: Effects of image content on performance and mood state. *Journal of Sport and Exercise Psychology, 12,* 66-73.

Lerner, B. S., Ostrow, A. C., Yura, M. T., & Etzel, E. F. (1996). The effects of goal-setting and imagery training programs on the free-throw performance of female collegiate basketball players. *The Sport Psychologist, 10*(4), 382-397.

Li-wei, Z., Qi-wei, M., Orlick, T., & Zitzelberger, L. (1992). The effect of mental-imagery training on performance enhancement with 7-10-year-old children. *The Sport Psychologist, 6*(3), 230-241.

Livesey, D.J. & Kangas, M. (1997). The role of visual movement imagery in kinaesthetic sensitivity and motor performance. *The Australian Educational and Developmental Psychologist, 14* (1), 2 - 10.

Livesey, D. J. (2002). Age differences in the relationship between visual movement imagery and performance on kinesthetic acuity tests. *Developmental Psychology, 38*(2), 279-287.

Mace, R. D., & Carroll, D. (1985). The control of anxiety in sport: Stress inoculation training prior to abseiling. *International Journal of Sport Psychology, 16,* 165-175.

Mace**,** R. D., Eastman, C., & Carroll**,** D. (1987). The effects of stress inoculation training on gymnastics performance on the pommel horse: A case study. *Behavioural Psychotherapy, 15*(3), 272-279.

MacKay, D. G. (1981). The problem of rehearsal or mental practice. *Journal of Sport and Exercise Psychology, 17,* 54-69.

Madigan, R., Frey, R. D., & Matlock, T. S. (1992). Cognitive strategies of university athletes. *Canadian Journal of Sport Sciences, 17*(2), 135-140.

Mahoney, M. J., & Avener, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive Therapy and Research, 1,* 135-141.

Marks, D. F. (1983). Mental imagery and consciousness: A theoretical review. In A. A. Sheikh (Ed.), *Imagery: Current theory, research, and application* (pp.96-130). New York: Wiley.

Martin, K. A., & Hall, C. R. (1995). Using mental imagery to enhance intrinsic motivation. *Journal of Sport and Exercise Psychology, 17,* 54-69.

Martin, K. A., Mortiz, S. E., & Hall, C. R. (1999). Imagery use in sport; A literature review and applied model. *The Sport Psychologist, 13,* 245-268.

McKenzie, A., & Howe, B. L. (1997). The effects of imagery on self-efficacy for a motor skill. *International Journal of Sport Psychology, 28,* 196-210.

Moely, B. E., Hart, S. S., Leal, L., Santulli, K. A., Rao, N., Johnson, T., & Hamilton, L. B. (1992). The teacher's role in facilitating memory and study strategy development in the elementary school classroom. *Child Development, 63*(3), 653-672.

Moran, A., & MacIntyre, T. (1998). There's more to an image than meets the eye: A qualitative study of kinaesthetic imagery among elite canoe-slalomists. *Irish Journal of Psychology, 19*(4), 406-423.

Moritz, S. E., Hall, C. R., Martin, K. A., & Vadocz, E. (1996). What are confident athletes imaging? An examination of image content. *The Sport Psychologist, 10* (2), 171-179.

Munroe, K. J., Hall, C. R., Simms, S., & Weinberg, R. S. (1998). Athletes' use of imagery early and late in their competitive season. *The Sport Psychologist*, *12,* 440-449.

Munroe, K. J., Giacobbi, P. R., Hall, C., & Weinberg, R. (2000). The four Ws of imagery use: Where, when, why, and what. *The Sport Psychologist*, *14*(2), 119-137.

Munroe, K. J., Hall, C. R., Simms, S., & Weinberg, R. S. (1998). Athletes' use of imagery early and late in their competitive season. *The Sport Psychologist, 12,* 440-449.

Murphy, S.M. and Jowdy, D.P. (1992). Imagery and Mental Practice. In T.S. Horn (Ed.), Advances in Sport Psychology (pp. 221-245). Champaign, IL: Human Kinetics Publishers.

Mwanalushi, M. (1974). Imaginal factors in the coding of random patterns by children. *Child Development, 45,* 204-207.

Orlick, T. (1990). *In pursuit of excellence* (2nd ed.). Champaign, IL: Human Kinetics.

Orlick, T., & Partington, J. (1988). Mental links to excellence. *The Sport Psychologist*, *2,* 105-130.

Overby, L. Y. (1990). A comparison of novice and experienced dancers' imagery ability. *Journal of Mental Imagery,14*(3-4), 173-184.

Ozel, S., Larue, J., & Molinaro, C. (2004). Relation between sport and spatial imagery; comparison of three groups of participants. *The Journal of Psychology, 138,* 49-63.

Page, S. J., Sime, W., & Nordell, K. (1999). The effects of imagery on female college swimmers' perceptions of anxiety. *The Sport Psychologist*, *13,* 458-469.

Paivio, A. (1971). *Imagery and Verbal Processes*. New York: Holt, Rinehart and Winston.

Paivio, A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Sciences*, *10*, 225-285.

Patrick, T. D., & Hrycaiko, D. W. (1998). Effects of a mental training package on an endurance performance. *The Sport Psychologist, 12*(3), 283-299.

Peynircioglu, Z. F., Thompson, J. L., & Tanielian, T. B. (2000). Improvement strategies in free-throw shooting and grip-strength tasks. *The Journal of General Psychology*, *127*, 145-156.

Philippaerts, R. M., & Lefevre, J. (1999). Reliability and validity of three activity questionnaires in Flemish males. *American Journal of Epidemiology*, *147*, 982-990.

Philippaerts, R. M., Westerterp, K. R., & Lefevre, J. (1999). Doubly labeled water validation of three physical activity questionnaires. *International Journal of Sports Medicine, 20,* 284-289.

Piaget, J. (1970). Piaget’s theory. In P. H. Mussen (Ed.), *Carmichael’s manual of child psychology,* (3rd edition). New York: Wiley.

Piaget, J., Inhelder, B., & Szeminska, A. (1960). *The Child’s Conception of Geometry.* New York: Harper & Row.

Pressley, M., Johnson, C. J., Symons, S., McGoldrick, J. A., & Kurita, H. (1989). Strategies that improve children's memory and comprehension of text. *Elementary School Journal, 90*(1), 3-32.

Pressley, M., & Levin**,** J. R. (1980) The development of mental imagery retrieval. *Child Development, 51*(2), 558-560.

Rotella, R. J., Gansneder, B., Ojala, D., & Billing, J. (1980). Cognitions and coping strategies of elite skiers: An exploratory study of young developing athletes. *Journal of Sport Psychology, 2,* 350-354.

Rushall, B. S. (1988). Covert modeling as a procedure for altering an elite athlete’s psychological state. *The Sport Psychologist, 2,* 131-140.

Ryan, E. B., Ledger, G. W., & Weed, K. A. (1987). Acquisition and transfer of an integrative imagery strategy by young children. *Child Development, 58,* 443-452.

Sackett, R. S. (1934). The influences of symbolic rehearsal upon the retention of a maze habit. *Journal of General Psychology, 13,* 113-128.

Sears, N. C., & Johnson, D. M. (1986). The Effects of Visual Imagery on Spelling Performance and Retention among Elementary Students. *Journal of Educational Research, 79*.

Shelton, T. O., & Mahoney, M. J. (1978). The content and effect of "psyching-up" strategies in weight-lifters. *Cognitive Therapy and Research*, 2, 275-284.

Smith, D. (1987). Conditions that facilitate the development of sport imagery training. *The Sport Psychologist, 1,* 237-247.

Smyth, M. M., & Waller**,** A. (1998). Movement imagery in rock climbing: Patterns of interference from visual, spatial and kinaesthetic secondary tasks. *Applied Cognitive Psychology, 12*(2), 145-157.

Straub, W. F. (1989). The effect of three methods of mental training on dart throwing performance. *The Sport Psychologist, 3,* 133-141.

Suinn, R. M. (1980). Psychology and sport performance: Principles and applications. In R. M. Suinn (Ed.), *Pyschology in sports: Methods and applications* (pp. 26-36). Minneapolis: Burgess.

Suinn, R. M. (1996). Imagery rehearsal: A tool for clinical practice. *Psychotherapy in Private Practice, 15,* 27-31.

Sweigard, L. E. (1974). *Human movement potential: Its ideokinetic facilitation.* New York: Harper & Row.

Taylor, J. (1987). Predicting athletic performance with self-confidence and somatic and cognitive anxiety as a function of motor and physiological requirements in six sports. *Journal of Personality, 55,* 139-153.

Tabachnick, B.G. and Fidell, L.S. (1996). Using Multivariate Statistics. NY: HarperCollins.

Vadocz, E., Hall, C. R., & Mortiz, S. E. (1997). The relationship between competitive anxiety and imagery use. *Journal of Applied Sport Psychology, 9*, 241-253.

Vandall, R. A., Davis, R. A., & Clugston, H. A. (1934). The function of mental practice in the acquisition of motor skills. *Journal of General Psychology*, *29*, 243-250.

VanDenberg, L., & Smith, D. E. (1993). The effects of imagery on competitive anxiety in high school wrestlers. Paper presented at the meeting of the Association for the Advancement of Applied Sport Psychology, Montreal, QB.

Varley, W. H., Levin**,** J. R., Severson**,** R. A., & Wolff, P. (1974). Training imagery production in young children through motor involvement. *Journal of Educational Psychology*, *66*(2), 262-266.

Vealey, R. S. (1986). Conceptualization of sport confidence and competitive orientation; Preliminary investigation and instrument development. *Journal of Sport Psychology*, *8*, 221-246.

Vealey, R. S., & Greenleaf, C. A. (2001). Seeing is believing: Understanding and using imagery in sport. In J. M. Williams (Ed.), *Applied Sport Psychology: Personal growth to peak performance* (pp. 247-272). Mountain View, CA: Mayfield Publishing Company.

Vealey, R. S., & Walter, S. M. (1993). Imagery training for performance enhancement and personal development. In J. M. Williams (Ed.) *Applied Sport Psychology: Personal growth to peak performance* (2^{nd} ed., pp. 200-224). Mountain View, CA: Mayfield.

Wang, Y., & Morgan, W. P., (1992). The effects of imagery perspective on the physiological responses to imagined exercise. *Behavioural Brain Research, 52,* 167-174.

Weinberg, R. S. (1982). The relationship between mental preparation strategies and motor performance: A review and critique. *Quest, 33,* 195-213.

Weiss, M. R. (1991). Psychological skill development in children and adolescents. *The Sport Psychologist, 5,* 335-354.

White, A., & Hardy, L. (1995). Use of different imagery perspectives on the learning and performance of different motor skills. *British Journal of Psychology, 86,* 169-180.

White, A., & Hardy, L. (1998). An in-depth analysis of the uses of imagery by high-level slalom canoeists and artistic gymnasts. *British Journal of Psychology, 12*, 387-403.

Williams, J. D., Rippon, G., Stone, B. M., & Annett, J. (1995). Psychophysiological correlates of dynamic imagery. *British Journal of Psychology, 86,* 283-300.

Willoughby, T., Porter, L., Belsito**,** L. (1999). Use of elaboration strategies by students in grades two, four and six. *Elementary School Journal, 99*(3), 221-231.

Wolff**,** P., & Levin**,** J. R. (1972). The role of overt activity in children's imagery production. *Child Development, 43*(2), 537-547.

Wrisberg, R. L., & Anshel, M. H. (1989). The effect of cognitive strategies on the free throw shooting performance of young athletes. *The Sport Psychologist, 3*, 95-104.

Wrisberg, R. L., Murphy, S. M., Gottesfeld, D., & Aitken, D. (1985). Effects of mental rehearsal of task motor activity and mental depiction of task outcome on motor skill performance. *Journal of Sport Psychology, 7,* 191-197.

Younis, J., & Dean, A. (1974). Judgement and imaging aspects of operations: a Piagetian study with Korean and Costa Rican children. *Child Development*, *45*, 1020-1031.