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Using Attentional Strategies for Balance Performance and Learning in Nine Through 12 Year Olds

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Using Attentional Strategies for Balance Performance and Learning in Nine Through 12 Year Olds

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ABSTRACT

The present study examined the influences of instructions that directed the learner's attention to either an internal focus or external focus on the performance and learning of a dynamic balance task. The instructions given were related to either the participant's own body movements (internal focus) or to the effects their movements had on the apparatus (external focus) (Wulf et. al, 1998). The purpose of this study was to investigate balance performance and learning in 9-12 year old children using internal and external focus of attention strategies. Participants were 9-12 year olds (*N*= 88) from intact physical education classes at a K-12 public school in Tallahassee, Florida. The hypotheses tested were instructions referring to an external focus of attention would be more effective in promoting balance performance and learning than internal focus instructions for 9-10 year olds and 11-12 year olds. Participants were randomly assigned into an external focus group, internal focus group and control group for 9-10 year olds and 11-12 year olds. A Biodex Dynamic Balance System was used to measure select dependent variables (overall stability, anterior/posterior stability, medial/lateral stability, mean deflection, anterior/posterior deflection and medial/lateral deflection) for six instructional set trials. A questionnaire was given to participants following the testing trials to examine whether or not participants were focusing on the instructional set cues. The instructional set cues were as follows: stand as still as possible while "keeping your feet still" (internal focus), stand as still as possible while "keeping the platform still" (external focus), stand as still as possible (control group). Two days following the testing trials, each group completed three retention trials with no focus of attention instructions provided. Participants who were given an external focus cue and said they used it based on the results of the questionnaire were significantly better in balance performance and learning than those who were given an internal focus cue and said they used it. All participants who said they used an external focus cue regardless of what focus group they were

randomly assigned were better in balance performance and learning than participants who said they used an internal cue.

CHAPTER 1

Introduction

The development and maintenance of postural stability is critical in the acquisition of motor skills. Recent studies in motor learning have determined that the effects of different types of instruction using focus of attention strategies have enhanced complex motor skill learning. The benefits of adopting an external focus of attention for adults may have the same benefits for balance performance and learning for young children. Verbal cues using attentional strategies during a task presentation can be an effective method of teaching in physical education.

Review of Literature

The objective of this review of literature is to establish a thorough understanding of how balance is controlled and developed by children, how focus of attention affects balance and sports skills and how attentional strategies are being used in physical education. An overview of balance control is provided followed by an examination of findings associated with the development of balance in children.

Secondly, a description of attentional focus strategies and their influences on balance learning is presented. Next, the influences of balance learning and the benefits of an external focus of attention on learning various sports skills are provided. Finally, this review considers the implications of attentional strategies as methods for teaching motor skills in physical education.

Developmental Aspects of Balance and Focus of Attention

The ability to sustain balance is essential for the execution of motor tasks. Balance is a major component in every motor task of human performance. The only time balance is not necessary is when the body is completely supported, such as lying down on a flat, horizontal surface or sitting in a car, strapped in by a safety belt. There are some activities that require more balance than others, such as riding a bicycle or surfing, and a person's ability to perform these skills is effected by their amount of balance and postural control (Burton & Davis, 1992). Before considering the contribution of attentional focus to balance learning, one must look at the underlying strategies used by the central nervous system in order to maintain equilibrium.

<u>Balance Control</u>

Balance control primarily consists of maintaining the body's center of mass within the base of support. Changes in equilibrium undergo certain conditions such as the body's movement from one location to another in relation to the environment, as in running from first to second base in softball. Environmental conditions, such as the beginning movement of a treadmill can create changes in equilibrium. Lastly, changes in position of the body's extremities in relation to the body, such as hitting a forehand drive in tennis, effects how a person must adapt his/her balance control (Burton & Davis, 1992).

Information used to control the state of equilibrium is provided primarily through the visual, tactile, and vestibular systems, as well as the proprioceptors including Golgi tendon organs, muscle spindles, and joint receptors. Exterioceptive information is about the body's movement relative to the environment and is provided by vision and the vestibular system. Proprioception is information about the movements of the extremities in relation to the body, which is provided by the Golgi tendon organs, muscle spindles and joint receptors. The visual and tactile systems can provide both exterioceptive and proprioceptive information (Schmidt & Lee, 1999).

The information necessary to control balance is provided by all the above systems. Combinations of information are received from vision, vestibular systems and proprioceptive systems as well as the tactile sense that provides information about contact with a support surface. Motor responses are coordinated with the muscles of the trunk, legs and feet. The brain's ability to put together these sensory and motor processes and adapt them to changes in the environment is the underlying strategy for balance and control. If any of these systems provide the learner with insufficient information, there is the possibility of loss of balance (NeuroCom International, 2003).

Balance Control from a Developmental Perspective

The development and maintenance of stability is critical to the acquisition of complex motor skills. The interaction of the processes within the postural control system is responsible for the coordination of muscles and joints by organizing response patterns. This involves integrating visual, vestibular and support-surface somatosensory input and providing information to the postural control system (Shumway-Cook & Woollacott, 1985).

Shumway-Cook and Woollacott, (1985) examined the developmental changes in the patterns of variability in postural stability in children under ten years old. In particular, they sought to determine any age-related changes in which young children are dependent upon visual versus mechanical proprioceptive inputs in controlling postural stability, as well as their capacity to resolve inter-sensory conflicts.

A total of 21 children ages 15 months to ten years old participated in this study. Participants were placed into three age groups: 15-31 months, four to six years, and seven to ten years old. A moveable platform capable of measuring movement in the anterior-posterior plane and rotational movements of the ankle joints was used to measure postural responses. Surface electromyograms (EMG) were used to measure the gastrocnemius, tibialis anterior, hamstrings and quadriceps. Each participant was tested a minimum of three different sessions (45-minute sessions) to ensure observer repeatability over time. For the first two testing sessions the platform was stable and participants were instructed to close their eyes. Ten anterior and ten posterior horizontal platform translations were randomly sequenced during each session (Shumway-Cook & Woollacott, 1985).

In the final session participants (above three years old) were instructed to stand for five seconds during four different conditions. These conditions included: (a) normal stable platform with eyes open; (b) normal stable platform with eyes closed; (c) rotating platform perturbations with eyes open; and (d) rotating platform perturbations with eyes close.

Results indicated that all participants were consistent in controlling balance by existing patterns of distal and proximal muscles. Visual-vestibular inputs primarily controlled stance balance for participants under three years old. The four to six year olds demonstrated response patterns that were greater in variability in timing and amplitude relationships between distal and proximal muscle synergy than in seven to ten year olds. Also four to six year olds had responses latencies that were slower with an increase in postural sway without visual information than adults. This variability in responses for the four to six year olds represents a transition period in postural control. In the seven to ten year olds response patterns were comparable to an adult reference group, suggesting the integration of sensory inputs may have occurred. The results of this study have suggested that when the central nervous system uses visual-vestibular postural inputs to make fine adjustments in ankle and foot proprioception the emergence of mature postural control may begin by the age of seven to ten years old (Shumway-Cook & Woollacott, 1985).

A recent study by Rival, Ceyte, and Olivier (2005) investigated the developmental changes of static balance in children six to ten years old. They sought to determine the time course by which children adapt and maintain their static balance while keeping their eyes closed. Thirty children ages six, eight and ten (ten per group) and ten adults (age 24) used as a reference group participated in this study.

Participants were instructed to stand upright, arms comfortably at their sides, barefoot, on a platform, with their eyes closed. They were instructed to be as stable as possible on the platform for five trials (ten seconds/trial). Two measurements of sway were used to describe their postural behavior. The first measurement was the range of Center of Pressure (COP) in any given direction or magnitude. The second measurement was the speed of the COP displacement over each trial for ten seconds. This measurement represented the amount of activity required to maintain stability (Rival et. al, 2005).

Results indicated that static balance did not appear to be mature by the age of ten years old. Both the magnitude of COP in any direction and the speed of COP displacements were higher at ten years old than the adult reference group. The absence of visual information (eyes closed) may suggest that children up to ten years old are more visually dependent than adults. Although postural stability did improve with age, maturity level was not attained by ten years old.

Although sensory pathways and feedback mechanisms of postural control are established at an early age, research is not clear whether or not young children have the capabilities to predict changes in their equilibrium and make the appropriate postural adjustments ahead of time.

Riach and Hayes (1990) sought to determine the age in which children were able to anticipate as well as compensate for postural disturbances caused by their own voluntary movements. They also attempted to document when children begin to develop anticipatory patterns of adjustments in center of pressure (COP).

Children ages four through 14 were recruited from a summer sports program at a local university. Each subject stood with bare feet on a stable force platform. An accelerometer was secured on their right wrist to measure forward arm acceleration in a choice reaction time (CRT) task. A small signal light was positioned at eye level in front of the participants approximately 1.5 meters away. Participants were instructed to raise their right arm forward to a horizontal position as fast as possible after a green light appeared. If a red light appeared participants were instructed to raise their arm backward at a 45° angle as quickly as possible. An auditory warning preceded each light with a random fore period between an auditory warning and the light. Both green and red lights were displayed randomly. Force and moment of force signals from the force platform were entered into the computer and COP changes in the anterior and lateral planes were calculated. Each subject was given ten trials with only five forward trials recorded. The three trials with the greatest forward arm acceleration were analyzed (Riach & Hayes, 1990).

Results in the lateral plane, showed 88% of the participants demonstrating an anticipatory response in at least two out of the three trials. The consistency of the preparatory responses of the participants over the three trials increased across age groups. Participants four to six years old demonstrated inconsistent timing over the three trials. The inconsistency of postural responses was due to a high variance in timing of the preparatory postural response in the anterior-posterior plane and reaction time. The younger participants also demonstrated more background postural sway than the older participants. Large fluctuations in COP position may explain the reasons for the variances in anticipatory adjustments.

Riach and Hayes (1990) were unable to determine the earliest age in which postural adjustments appear since most of the participants tested were capable of generating some preparatory postural adjustments.

The reoccurring theme in each of these studies is that the development and maintenance of postural stability matures over time. The ability to effectively coordinate postural adjustments with the movement execution may be beyond the capabilities of young children and may not reach maturation until adulthood.

<u>Balance and Focus of Attention</u>

Recently motor learning studies have shown differences in balance control through internal and external attentional strategies. Instructions that direct the learner's attention to his/her body movements (internal focus), such as those in a physical education setting, are not as effective as those instructions directing the learner's attention to the movement effects (external focus). Specifically, giving instructions to learners in relation to their body movements has not been shown to be the most effective way of learning. However, when instructions direct the learner's attention to the effects of their movements on the environment (apparatus, implement), the external focus instructions have consistently been shown to produce more effective learning (Wulf, McConnel, Gartner & Schwarz, 2002).

A recent focus of attention study by Wulf, Weigelt, Poulter, & McNevin (2003), examined the learning of a complex balance task on a stabilometer.

Participants in the study were given a small wooden tube that contained a table tennis ball and were instructed to hold the wooden tube approximately waist high at a 90° angle while standing on a stabilometer. Participants were asked to keep the ball in the center of the small wooden tube by directing their attention to either external or internal focus conditions. The external focus condition directed the participants to keep the tube horizontal, the internal focus condition directed the participants to keep their hands horizontal while balancing on the stabilometer. Balance control was measured during seven, 90-s trials across two practice days on the stabilometer. The number of times the ball made contact with either side of the wooden tube was measured for the supra-postural task. On day three, a retention test was given for four trials in which no focus of attention instructions were provided. A transfer test consisting of three trials was given without the wooden tube. More effective learning took place as a result of external focus of attention. The results were the same for the transfer test when the tube was removed. The findings from the transfer test showed the importance of external focus on the performance of a postural control task as well as the learning effect of a new balance task.

The benefit of an external focus of attention is that it allows the learner to use automatic processes to control the movement. However, if the learner uses an internal focus of attention, he or she is more likely to consciously interrupt the control processes and therefore, inadvertently disrupt the automatic control processes (Wulf, McNevin, & Shea, 2001).

Wulf et al. (2001) designed an experiment to test the predictions of the constrained-action hypothesis and its relationship to attentional focus. The constrained-action hypothesis states that when learners use an internal focus of attention they may actually constrain or interfere with the automatic processes that would normally regulate the body movement. In contrast, an external focus allows the motor system to self-organize movement more naturally. This study sought to determine if adopting an external focus of attention promotes more automatic control processes than an internal focus of attention.

To test this hypothesis, Wulf et al. (2001) used a stabilometer that measures dynamic balance. The external focus group was instructed to focus on the tape placed on the platform in front of their feet. The internal focus group was instructed to focus on their feet and to keep them horizontal. A secondary probe reaction time task was also used to determine the attentional demands present under external and internal focus conditions. Performance on the secondary task can be related to the performance on the primary task. If the secondary task results in slow reaction times this can be interpreted as the primary task requiring more attention.

The primary task was to remain balanced by keeping the stabilometer platform horizontal for each 90-s trial. The secondary task was a hand-held button used to react to an auditory stimulus that came from a computer. The goal in the secondary task was to react to the stimulus as fast as possible. Days one and two consisted of seven 90-s trials. Day three was a retention test that also consisted of seven 90-s trials; however, no reminders were given for attentional focus.

Results confirmed the prediction that the constrained-action hypothesis was reduced when adopting an external focus of attention relative to an internal focus condition. The external focus group increased balance performance, increased frequency of responding and decreased attentional demands relative the internal focus group. The participants instructed to focus on markers that were placed in front of their feet on the platform (external focus) had a higher frequency of responding (smaller amplitude) to postural adjustments indicating a greater integration of the degrees of freedom associated with performing the motor task. Participants in the external focus group did not “constrain” the degrees of freedom and allowed a more automatic movement execution. In the primary task the external focus group produced smaller balance errors than the internal focus group. In the secondary task, the external focus group demonstrated lower RTs than the internal focus group. These results indicate a higher degree of automaticity and less conscious interference in the control processes during a dynamic balance task when an external focus of attention was adopted (Wulf, McNevin, & Shea, 2001).

Additional evidence for the benefits of adopting an external focus of attention was demonstrated by preventing learners from focusing on their movements through the use of an attention-demanding secondary task (Wulf & McNevin, 2003). Participants in this study practiced balancing on a stabilometer. The external focus group was instructed to focus on markers attached to the balance platform; the internal focus group focused on their feet. A third group, the attention-demanding secondary task group was instructed to shadow a story or repeat out loud a story presented to them while they balanced on the stabilometer. A control group balanced without any secondary task or attentional focus. Two days of practice on the stabilometer consisted of seven, 90-s trials for each group. A retention test consisting of seven, 92-s trials was performed on day 3, in which no instructions or reminders were given. Group three was not required to shadow on the retention test.

The results showed all groups demonstrated improvement over the course of the two practice days. On average the shadowing group had the largest number of balance errors, whereas the external focus group had the least number of balance errors. The internal and control group demonstrated similar balance errors and fell in between the external and shadow groups. During the retention test the external focus group produced the least number of balance errors and the other groups showed similar performances. These results provide evidence for the learning benefits of adopting an external focus.

Various Sports Skills and the Benefits of Adopting an External Focus of Attention

The instructions given to a learner who is in the process of acquiring a new skill are crucial. Instructions occur before and during practice and include information on how to perform the skill. Instructions can enhance the learning of more complex skills, such as sports skills, and it is important to direct a learner's attention to the most relevant aspects of the task that may not have been shown or attended to in a demonstration (Wulf, Hoess, & Prinz, 1998).

Focus of Attention and Complex Motor Skills

External focus strategies have shown to be an advantage for the acquisition of different sports skills. A study by Al-Abood, Bennett, Hernandez, Ashford and Davids (2002) examined the differences in external focus verbal instructions and visual search strategies in the basketball free throw. Verbal instructions are given to direct the learner's attention when performing a task. Consequently, verbal instructions can be given to direct the learner's attention when observing a model, to enhance task performance. The addition of measuring the learner's visual search strategy would confirm the possibility that any change in movement form and task outcome scores could be a direct result of verbal instructions. The purpose of this study was to examine whether an external focus of attention on the movement effects of a model's performance would lead to a better task performance than an external focus on the model's movement dynamics. Specifically researchers examined the learner's visual search strategies of external sources of information as a constraint on performance in the basketball free throw.

Participants were presented a video of six free throws. The video demonstration of the free throw allowed the participants to view the model's movement dynamics as well as the movement effects (ball trajectory relative to the basket). A pre-test of five free throws was given to each group followed by the observation of the model's movement on the video. An eye movement recording system was used to collect the visual search data. The movement effects group was instructed to focus on how the model scored the basket and that form was not important. Participants in the movement dynamics group were instructed to focus on the model's movement form. A post-test of five free throws was given.

The results revealed that the movement effects group outperformed the movement dynamics group in free throws on the posttest. This study supports previous studies on balance (Wulf et al., 1998; Shea & Wulf, 1999) in which directing the learner's attention to the movement effects enhances performance and benefits learning. The analysis of the participant's visual search strategies as it relates to the verbal instructions gives support that the influence of relevant information enhances the performance and acquisition of motor skills.

A study by Wulf, Lauterbach and Toole (1999) examined the learning advantages of an external focus of attention and the golf pitch shot. This study examined attentional strategies with participants who had no prior golf experience.

Participants were randomly assigned to either internal or external focus groups. Instructions were given on the grip, stance and posture of the pitch shot using a 9 iron. Instructions differed for the swing according to the focus group assignment. The instructions for the internal-focus group were directed at the swinging motion of the arms. The instructions for the external-focus group were directed toward the club moving like a pendulum. Each participant hit 10 balls from a predetermined distance, to a target for ten trials. A retention test using no attentional focus instructions was given the next day.

The participants given instructions that directed their attention on the motion of the club (external focus) performed better than those participants who were directed to focus on the swinging motion of their arms (internal focus). The external-focus group also performed better than the internal-focus group on the retention test.

Attentional Focus and Feedback

Wulf, McConnel, Gartner, & Schwarz (2002), compared the relative effectiveness of attentional focus and feedback for learning complex motor skills. In experiment one, specific target areas were marked on the opposite side of an indoor volleyball court. While performing an overhead volleyball serve, participants were allotted a maximum of four points if the serve landed into the center of the target. Less than four points were given dependent upon the distance away the ball landed from the center of the target. Instructions were given to each participant emphasizing the critical features of the overhead serve such as foot placement, ball toss, and contacting the ball.

The novice and advanced players were assigned either to the internal-focus feedback or external focus feedback conditions. The group conditions were as follows: novice-internal, novice- external, advanced-internal and advanced-external feedback groups. There were four feedback statements used by the experimenters that were similar in content. The difference between the types of feedback was internal-focus feedback made reference to the performer's own movements, and the external-focus feedback made reference to the performer's movement effects. In each of the feedback conditions, one of the four feedback statements was given after the fifth trial. Based on the previous five trials, the experimenter chose the feedback statement that referred to a specific critical feature of the skill that needed the most improvement. In addition, participants were videotaped during the first and last block of trials in both the practice and retention session for movement analysis. Each participant performed 25 practice trials in each of two practice sessions. The practice sessions were separated by one week. A retention test consisting of 15 trials was performed one week after the second practice session (Wulf, McConnel, Gartner, & Schwarz, 2002).

All groups demonstrated a consistent increase in accuracy when performing the volleyball serve; however, the external focus-feedback group resulted in greater accuracy of serves during practice sessions than internal focus-feedback, independent of skill level. Movement quality was assessed by a list of critical features for the volleyball serve. Two independent raters assessed the movement quality based on these critical features from the videotaped trials. The advance players had higher scores in movement quality than novice players. However, the external-focus feedback groups had higher scores in movement quality than internal-focus feedback groups. The benefits of adopting an external focus of attention were also demonstrated in the retention test one week later with no feedback instructions provided (Wulf, McConnel, Gartner, & Schwarz, 2002).

A follow-up study by Wulf et al. (2002b) examined the frequency of feedback and attentional focus. Essentially there are two types of feedback in motor skill learning, knowledge of performance (KP) and knowledge of results (KR). KP is similar to internal-focus feedback in that statements are given to the learner to focus on his/her own movements such as “feet should be shoulder width apart” and “weight on the balls of your feet” as in tennis. KR is similar to external-focus feedback in which the learner is given statements that refers to the result produced by the motor skill as in a service ace. Too much KP encourages the learner to focus on his/her own movements and can lead to detriments in motor skill learning. However, it is possible that frequent KR could be used to enhance motor performance if it induces an external focus of attention. The purpose of experiment two was to test the possible effects of feedback type and feedback frequency on focus of attention.

The participants in this study were university students with some experience in soccer. Participants were required to shoot lofted soccer passes at a target 15 meters away. Accuracy points were awarded based on the center of the target and the surrounding areas. Participants were randomly assigned to one of four groups: internal-focus with 100% feedback frequency, external-focus with 100% feedback frequency, internal-focus with 33% feedback frequency, external-focus with 33% feedback frequency. For the two groups receiving 100%feedback, feedback was given after every trial. For the two groups receiving 33% feedback, one of five feedback statements was given after every third trial. All participants performed 30 practiced trials and returned one week later to perform the retention test. During the retention test no feedback was provided to any of the groups (Wulf et al., 2002).

The results showed all groups increased in the accuracy of passing a soccer ball to a target. However, the two external-focus groups were more accurate in their soccer passes, independent of the feedback frequency, than the internal focus groups. Interestingly enough, the internal-focus group with 33% feedback frequency performed better than the internal-focus with 100% feedback frequency. On the no-feedback retention test, the external-focus feedback groups had an increase in accuracy scores over the trials than the internal-focus groups. The internal-focus group with 100% feedback had lower accuracy scores than the internal-focus group with 33% feedback (Wulf et al., 2002).

Both of these experiments have shown that if learners receive feedback relative to their movement effects rather than to their body movement patterns they may learn a motor skill more effectively.

External Focus Strategies and Verbal Cues

Wulf, McNevin, Fuchs, Ritter, and Toole (2000) provided additional advantages for adopting an external focus of attention. The purpose of this experiment was to determine whether there are advantages to directing the learner’s attention to the external effects of one’s movements relative to other types of external cues. In experiment one, participants with no prior experience in tennis were instructed to practice hitting tennis balls to a target on the other side of the court using a forehand stroke. Each participant was given ten “warm-up” trials with individual instruction and necessary feedback. Participants were randomly assigned to the antecedent group that focused on the ball coming toward them or the effect group that focused on the ball leaving the racket.

Both groups adopted an external focus, however only one group focused their attention on the movement effect. If focusing on the movement effects benefits learning, the participants that focus on the effect of their action may result in greater retention performance than those participants focusing on the antecedent of their action. All participants were given ten blocks of ten trials with small break intervals. A retention test was given the following day after the practice trials. The retention test consisted of three blocks of ten trials, in which no instructions were provided. A ball machine was used for consistency during the practice session and retention test (Wulf et al., 2000).

Both groups demonstrated an increase in accuracy in their shot placement throughout the practice trials; however, there was no significant difference between them. The effect group had higher overall scores on the retention test. The result of the retention test does provide evidence of the benefits of adopting an external focus of attention if the learner is directed to the movement effects rather than other external cues.

The results of the this study led to a second experiment to examine whether focusing on the outcome of one's action or focusing on the effect which is more related to the actual movement form is most beneficial for learning (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000).

In this study participants with no prior experience in golf were instructed to hit golf balls to a target. One group was instructed to focus on the anticipated trajectory of the ball to the target, similar to the previous experiment, the other group was instructed to focus on the golf club swing or movement effect on the golf club.

The task procedure was identical to the one used by Wulf, Lauterbach and Toole (1999). Participants were randomly assigned to the club group or target group. The target group focused on the trajectory of the ball to the target and the club group focused on allowing the club head to swing like a clock pendulum. The practice session consisted of eight blocks of ten trials. One day after the practice session, all participants were given a retention test of 30 trials. No instructions or reminders were given during the retention test.

The results showed the club group achieving higher accuracy scores than the target group throughout the practice session and the retention test. Instructions given to the club group directed the participants away from their actions and towards the effects of their movements on an implement. The participants in the club group showed evidence of performance benefits when instructed to focus on the motion of the club head than the target group. Novices need to develop a visual picture of the movement pattern they are trying perform. Directing the learner's attention toward the effects of their movements on an implement is more advantageous than the effects not directly to the movement such as a target (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000).

The present results extend previous findings by providing insights into how learning a motor skill can be affected by the instructions given to the learner. Adopting an external focus of attention can benefit motor skill performance and learning. Directing the learner’s attention to the appropriate cues can have beneficial effects on the performance of motor skills.

The Implications of Attentional Strategies as Methods for Teaching Motor Skills in Physical Education

As physical educators, strategies used to teach motor skills are found in visual and verbal cues. In visual cues, the learner copies the action observed during the task presentation of a motor skill. The learner receives visual cues to reinforce the sequence of skills or the essential components of a skill to maximize performance. Verbal cues are given to the learner for guidance as well as allow for self-instruction in their own performance (Valentini, 2004).

Information Processing and Verbal Cues

Verbal cues are concise phrases, possibly one or two words that are used to communicate specific information about a motor skill. Verbal cues direct the learner’s attention to relevant task stimuli or critical elements of the movement pattern of a motor skill. The physical education instructor provides verbal cues during instruction or feedback or students can be taught a self-talk regiment to direct their own learning. However, it is the information processing mechanism that provides a theoretical framework for verbal cues that allows the learner to recognize and recall relevant information pertaining to a motor skill (Landing, 1994).

The factors that influence information processing are perceptual, decision, and effector processing. All are necessary to direct a novice learner’s attention to relevant task stimuli. Perceptual processing abilities allow the learner to recognize the correct stimuli in a motor skill. For example, it is important for a novice tennis player to watch the ball, while learning the basic movement pattern of a forehand drive (Wrisberg, 1993).

The second factor that influences information processing is decision processing. According to Wrisberg (1993), verbal cues can aid in the decision making process by reducing the number of possible responses from which the novice learner must choose. Verbal cues are used in effector processing to guide the learner in the development of correct movement patterns by readying the involved muscle groups or effectors for the initiation of the movement. In volleyball, a blown whistle prior to the serve allows the receiving team to ready the effectors of the arms in the pass position. Verbal cues can also facilitate the chunking of information to perform a sequence of a skill. In the volleyball example above, the learner has to be able to chunk the necessary information to accurately pass the ball to the setter (Wrisberg, 1993).

The role of verbal cues in attention and information processing functions can be classified as Augmented Verbal Cues (AVC) or Self-Talk Regimens (STR). Augmented Verbal Cues (AVC) direct the learner's attention to specific components during a demonstration of a motor skill. AVC highlights the sequence and relative timing of a complex motor task. These cues draw the attention of the learner to necessary information and aids in the decision making process during the performance of a motor skill. AVCs enhance the qualitative aspect of a movement by allowing the learner to focus his/her attention on a particular cue during practice and by therefore blocking out any possible irrelevant stimuli (Landin, 1994).

A number of learners may not attend to and learn the information relative to a skill during a task presentation. Self-Talk Regimens (STR) use verbal cues to increase the learner's active involvement with a motor task. STR use verbal cues to prompt key elements of the skill for attentional focus. For example, in a basketball game the learner may use self-talk to remind him or herself to focus on the backboard during a free throw.

Verbal Cues in Physical Education

Typically, when learning a new skill in a physical education class the students are given various verbal cues called teaching cues that provide instructions about the correct movement pattern of the skill. A teaching cue is a verbalized word or phrase or an action that communicates the critical features of a movement skill to the learner (Rink, 1998). For example, in learning the volleyball forearm pass, the learner is told where the feet should be placed; how to place his/her hands together to make a platform with their arms, where to contact the ball; and how to direct the ball to a target.

Teaching cues can be classified into two categories; teacher-initiated and student-initiated cues. Teacher-initiated cues are cues in which the physical education instructor provides the words that focus the learner's attention to the critical elements of the skill. Teacher-initiated cues help the learner to understand the "how to" of a movement pattern. For example, "place your hands together to make a platform with your arms" (Parson, 1998).

Student-initiated cues or self-cues allow learners to give themselves cues to prompt action and direct their attention to the critical elements of the movement skill. For example, as the learner performs a pitch shot in golf, he or she can say, "think of the club head as a clock pendulum" (Parson, 1998).

Teaching cues are used in both open and closed skills. According to Gentile's (1972) two-dimensional model, motor skills are classified as open and closed. A closed skill is characterized by very little change in environmental conditions. The learner is in temporal control of the beginning and ending movements, as well as spatial control of direction and position of the movements (Gentile, 1972). In a closed skill such as a golf pitch shot, teaching cues provide a visual for the critical elements and correct movement of the skill (Parson, 1998).

An open skill is characterized by an unpredictable, dynamic environment in which the object and/or individual changes. The learner must make adjustments for the temporal and spatial demands in response to the environment (Kluka, 1999). For an open skill, such as a tennis game, teaching cues focus on movement responses where the learner must adapt to changing conditions in the environment (Parson, 1998).

When considering visual and verbal cues, a physical educator needs to be aware of the stage of development of the learner. Depending upon the level of the learner, specific teaching cues are given to execute the skill properly. In volleyball a beginner may be given any of the following verbal cues for the forearm pass: knees slightly bent, face the target, one foot slightly in front of the other, heels of the hands and thumbs together, make a fist, arms straight, elbows locked in front of the body and contact the ball in the middle of the forearms (Fielitz, Petersen & Docheff, 1999).

Verbal cues are most effective when they are concise phrases, usually no more than 3-4 words. Verbal cues need to be accurate and relevant to the motor performance of a task. It is imperative that verbal cues contain information that directs the learner's attention to critical components of the movement pattern. Verbal cues can be designed into segments of a motor task. For example; verbal cues can be used in segments for ground strokes in tennis, such as the backswing and follow-through. Verbal cues are dependent upon the type of task. For example, if a task is a closed skill the learner can be directed towards the elements of the movement pattern. If the task is an open skill, the learner should be given verbal cues directing his/ her attention to relevant stimuli that will in turn trigger the necessary motor response (Landin, 1994).

Verbal cues in physical education are used to guide, motivate and instruct the learner. However, the implementation of verbal cues is the key to better performance of the skill. Too many verbal cues can overwhelm the learner's ability to process information. Too few verbal cues, the learner may not receive enough information and possibly fall short of mastering the skill. During a task presentation in a physical education class, verbal cues should be given while demonstrating the skill. Verbal cues should focus the learner's attention on the critical elements of the skill. Finally, verbal cues should be used while the learner is performing the skill (Magill, 1998).

<u>Examples of Verbal Cues in Physical Education and Focus of Attention</u>

Developing content in physical education is a process that provides the learner with sequential experiences for learning concepts and motor skills. This content development process was created by Rink (2002) to help physical education teachers with lesson planning. There are four functions performed during a lesson to help students learn various concepts and skills. The four functions in the developmental content of a lesson are (1) informing: providing information about the concept or skill as well as giving a description of how to perform the task; (2) extending tasks: making the task more difficult or easier for the students based on ability; (3) refining tasks: providing the students with "cues" or critical elements that will enhance performance of the skill; and (4) challenging or application; motivating the students to practice the task or showing them how the task can be applied (Rink, 2002).

Attentional strategies can be found in verbal cues used in the content development process of physical education. The following internal focus cues have been used for balancing on stationary equipment: "tight muscles" (muscle tension), "extensions" (extend free body parts for stability). An external focus cue "eyes forward" (focusing on a spot on the wall) has been used for balancing on a large apparatus such a balance beam or bench while traveling from one end to the other (Graham, Holt/Hale, Parker, 2004).

Verbal cues for rolling forward such as "C" back (round your back like the letter C), tuck (tuck your chin in your chest), hike (hike your bottom up high in the air), and push (push off with your legs and make sure your weight is on your arms) uses mainly internal focus cues. Examples of verbal cues used for more complex motor skills such as the volleyball overhead set are "crab fingers" (external focus), bend your knees and extend your legs and arms upward (internal focus) and quick feet (internal focus) (Graham, Holt/Hale, Parker, 2004).

Verbal cues for striking an object over a net may be "paddle face" (paddle will be flat or slightly slanted), "watch the ball" (see the ball contact the paddle), "watch the target" (see the ball go to the target) and "opposite foot/same foot" (step forward with opposite foot for the forehand, or same foot for the backhand). Verbal cues for striking an object tend to favor an external focus of attention. Cues for catching a ball from a partner may be "watch the ball" (keep your eyes on the ball, see it come into your hands), "reach" (reach for the ball), "pull it in" (pull the ball toward you, soft catching), "get behind" (position your body so that you are behind the ball). Catching uses a combination of internal and external focus cues (Graham, Holt/Hale, Parker, 2004).

How teachers use verbal cues has important implications for teaching in physical education. In physical education teacher preparation programs the emphasis on the use and accuracy of cues to teach motor skills is part of the process for developing content for effective teaching. Adopting an external focus of attention in the content development process would be an effective strategy for teaching motor tasks for all levels of learning.

Pilot Study

The purpose of my pilot study was to address dynamic balance control in college students using internal and external focus of attention strategies. I hypothesized that the instructions referring to the external focus, that is the target on the wall, would be more effective than those instructions directing the learner's attention to their own body movements (internal focus).

Participants in this study were twenty males and females (Mean=22 years old), who volunteered from a Human Movement Studies class at Florida State University, in Tallahassee, Florida. Participants were not aware of the purpose of study.

The Biodex Balance System is an instrument used to assess neuromuscular control by quantifying the ability to maintain dynamic unilateral postural stability on an unstable surface (Biodex Medical, 1998). Each test can be calibrated to a specific stability level (level 1-least stable, level 8-most stable). The balance test used in this study was calibrated at level 4. Participant information of height (cm), weight (lbs) and age was entered into the program. The test duration for each trial was 20 seconds.

Each participant was randomly assigned to do the internal or external focus condition first for each dynamic balance task. One practice trial was given prior to any tests using a focus condition. Participants completed two trials for each condition. Once the centering on the platform was achieved and the curser moved to the center of the target, the target screen was covered with a hand towel and the platform was released for the first of two balance trials. The internal focus conditions were to focus on keeping their ankles steady during each 20-second trial. The external focus conditions were to focus on a target placed at eye level, on the wall directly in front of them. This target simulated the target found on the Biodex computer screen. The order of attentional focus instructions was evenly distributed across the participants. Each participant completed two trials under each condition.

Dependent variables included: average overall stability- variance of platform displacement in degrees from level, average anterior/posterior stability- variance of platform displacement in degrees from level for motion in the sagittal plane. Average mean deflection- average position for the participant in all motions throughout the test, and average anterior/posterior deflection- the average forward and backward motion.

Dependent variables were analyzed using a one-way analysis of variance (ANOVA) with repeated measures for the types of attentional focus. Data were averaged from the two trials for internal focus and external focus of attention. Confidence level was set at 0.05.

The results of each dependent variable were as follows:

Average overall stability exhibited by internal and external focus conditions can be seen in Figure 1. Analysis of overall stability revealed main effects of attentional focus, $F(1,19) = 6.31$, $p = .02$. The external focus condition resulted in less variation and better overall stability than the internal focus condition with means and standard deviations of 3.78 ± 1.49 and 4.8 ± 2.14, respectively. The external focus condition resulted in more balance control and stability.

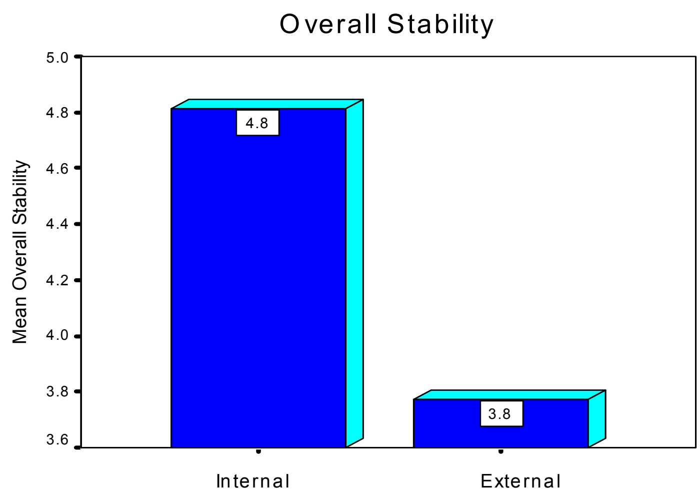

Figure 1. Overall Stability Trials

In Figure 2 average anterior/posterior stability revealed a similar main effect for attentional focus as average overall stability, *F* (1,19) = 6.7, p =.018. The external focus conditions resulted in less variance in platform displacement in the sagittal plane than internal focus conditions with means and standard deviations of 3.16± 1.41 and 4.29± 2.23, respectively. Participants demonstrated less motion and more balance control in the anterior and posterior plane during external focus conditions.

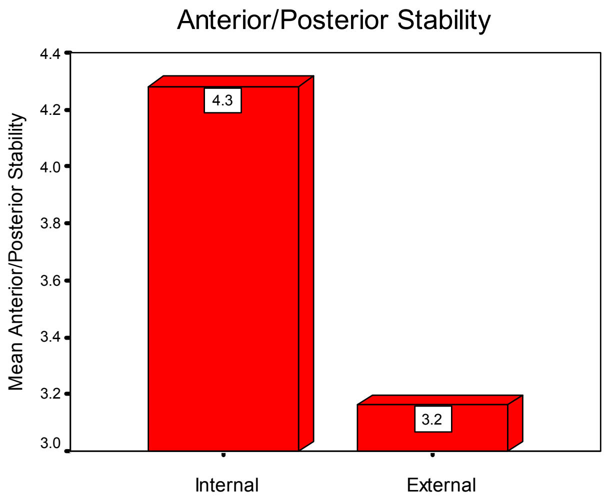

Figure 2. Anterior and Posterior Stability Trials

In Figure 3 average mean deflection also revealed significant main effects for focus of attention, $F\,(1,19) = 5.75$, p =.027. The average mean deflection for external focus conditions revealed more neuromuscular control on the platform than internal focus conditions with means and standard deviations of 3.01$\pm$ 1.43 and 4.04$\pm$ 2.2, respectively. The external focus conditions allowed the participants more neuromuscular control to remain centered on the Biodex platform during each 20-second trial.

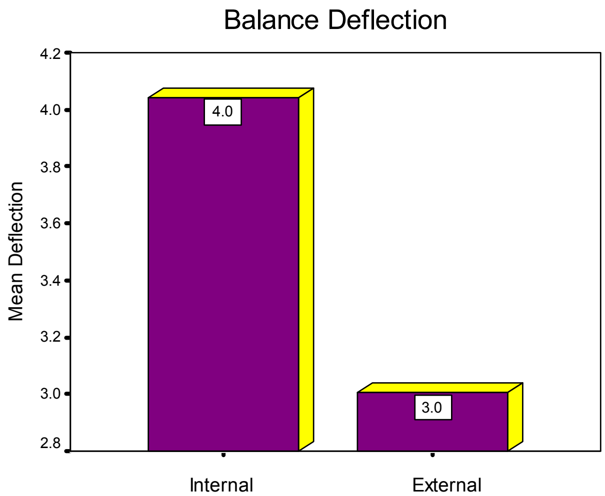

Figure 3. Mean Deflection Trials

Analysis of the average anterior/posterior deflection revealed a main effect of attentional focus, $F\,(1,19) = 4.74$, $p = .042$. The average anterior/posterior deflection was more centered in the sagittal plane for external focus conditions than during internal focus conditions with means and standard deviation 1.91 ± 1.44 and 2.99 ± 2.46, respectively. These results can be seen in Figure 4.

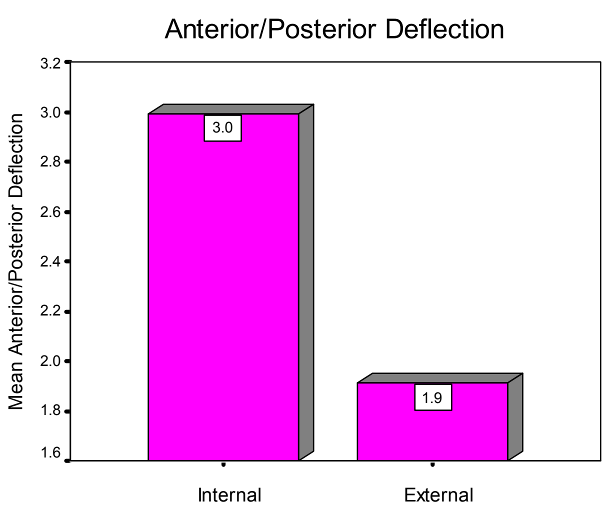

Figure 4. Anterior and Posterior Deflection Trials

In this study, attentional focus was examined to see the effects on motor performance of a dynamic balance task for college-age students. The results showed participants were able to balance more efficiently when they adopted an external focus of attention. Specific variables such as average overall stability, average anterior/posterior stability; average mean deflection and average anterior/posterior deflection were investigated because these variables are related to maintaining good balance and postural control in sports skills. Any changes in these variables in response to attentional focus instructions would suggest a possible strategy for teaching motor skills in which balance is a primary factor.

For each variable there were performance benefits when adopting an external focus of attention. With respect to average overall stability the external focus condition resulted in better balance and control (less variability) compared to the internal focus condition. For the average anterior/posterior stability, another measure of variability, the external focus condition provided less motion and more balance control than the internal focus condition. Average mean deflection resulted in greater neuromuscular control (less deflection from the center) on the platform for the external focus condition, whereas the average anterior/posterior deflection allowed participants to be more centered in the sagittal plane for the external focus condition. Directing the attention to the movement effects (external focus) resulted in better performance for the dynamic balance task than directing the learner to their body movements (internal focus).

These findings extend the results of previous studies by demonstrating the benefits of an external focus of a complex supra-postural balance task using a stabilometer (McNevin & Wulf, 2002; Wulf, Weigelt, Poulter, & McNevin, 2003). Participants were randomly assigned an attentional focus condition and it was interesting to see that the external focus condition resulted in a presumably automatic adjustment in their balance and postural control. This suggests that as participants were instructed to direct their attention on the target on the wall (external focus) they were able to utilize the automatic control processes they had available, and maintained better balance. The external focus instructions promoted the use of higher-level control processes and led to more effective performance (Wulf & Prinz, 2001).

Statement of the Purpose

The purpose of this study was to investigate balance performance and learning in nine through 12 year old children using internal and external focus of attention strategies.

Hypotheses

With respect to the purpose of this study, the following two hypotheses were established.

Hypothesis 1: For the nine and ten-year-old age group, instructions referring to an external focus of attention will be more effective in promoting balance performance and learning than internal focus instructions. Studies have examined postural stability using electromyography (EMG) activities and center of foot pressure (COP) and found children four to six years and ten years old and under to be less efficient in the control of either static or dynamic balance (Riach & Hayes, 1990; Rival, Ceyte, & Olivier, 2005). It may be that automatic control processes for balance are less developed at this age and using external focus of attention instructions may promote automatic processing control for balance performance and learning. Since it has been proposed that an external focus frees the central nervous system (CNS) to modulate automatic processes (Wulf et al, 2001), those who have a lower level of automatic control may benefit from external focus. It may be that external focus will allow the CNS the freedom to use proprioceptive feedback at lower and higher levels. This freedom could promote CNS adjustments to balance perturbations without interruptions from higher levels and enhance balance control.

Hypothesis 2: For the 11 and 12-year-old age group, instructions referring to an external focus of attention will be more effective in promoting balance performance and learning than internal focus instructions. Postural stability is more developed due to age maturation. Eleven and 12 year olds are more likely than four to 10 year olds to anticipate postural disturbances and make adjustments to control balance (Riach & Hayes, 1990). Therefore, directing the learner's attention to the effects of their movements (external focus of attention) may enhance automatic control processes, including anticipation of postural disturbance, by allowing adjustments to balance perturbation to be unconstrained. This autonomy provided to the CNS by an external focus may well serve to enhance balance performance and learning.

Definition of Terms

Biodex Dynamic Balance System: Assesses neuromuscular control by quantifying the ability to maintain dynamic unilateral postural stability on an unstable surface.

Overall Stability: Represents the variance of platform displacement in degrees from level.

Anterior/Posterior Stability: Represents the variance of platform displacement in degrees from level for motion in the sagittal plane.

Medial/Lateral Stability: Represents the variance of platform displacement in degrees from level for motion in the frontal plane.

Mean Deflection: The average position for the participant in all motions throughout the test.

Anterior/Posterior Deflection: The average forward and backward motion.

Medial/Lateral Deflection: The average motion from side to side (Biodex Medical, 1998).

Assumptions

The following were assumptions associated with this study:

1. The Biodex Balance System was assumed to assess neuromuscular control by quantifying the ability to maintain dynamic postural stability on an unstable surface.
2. The balance test used for this study was calibrated at level 3 (level 1-least stable, level 8-most stable). The platform stability was assumed to be at an appropriate difficulty level based on pilot data with college-age adults and children eight to 12 years old.

Limitations

This study was limited in the following manner:

1. This study was limited to one school located in Tallahassee, Florida.
2. The sample was limited to nine through 12 year olds taken from intact physical education classes, at Florida State University School.
3. Due to intact physical education classes, participants were limited to the random assignment groups.

Significance of the Study

The significance of this study was twofold. First while the development and implementation of attentional focus strategies represent a recent area of study, there has been a growing concern that paying attention to one's own movements during the learning of motor skills can disrupt the learner's performance (Wulf & Weigelt, 1997). Preliminary evidence suggests that an internal focus of attention constrains the motor system by interfering with the natural control processes, while an external focus of attention seems to promote automatic control processes during motor skill acquisition (Wulf & Prinz, 2001).

The development and maintenance of postural stability is critical to the acquisition of motor skills. The benefits of adopting an external focus of attention for adults may have the same benefits for balance performance and learning for young children.

Secondly, the benefits of adopting an external focus of attention when giving verbal cues can be an effective method of teaching in physical education. In a physical education teacher preparation program, preservice teachers are taught pedagogical skills necessary to teach motor skills. Rink (2002) developed a methodology for teaching cues that are used during a task presentation. Being able to analyze and break down the critical elements of the skill is an essential part of this task presentation. The physical education teacher will need to be able to develop accurate verbal cues to enhance the attention to critical components of the task and prompt key elements of the skill's movement pattern. For example, during a volleyball service lesson, a physical education instructor may use the following verbal cue: "shift your weight from the back leg to the front leg". This verbal cue directs the learner to his/her own movements or provides an internal focus of attention. This same verbal cue can direct the learner's attention to the movement's effects by simply saying "shift your weight toward the target" on the other side of the net (Wulf et al., 2002).

Currently attentional strategies are being used in physical education. Verbal cues enhance the quality of the movement pattern and benefit performance and learning. This study may determine the effectiveness of verbal cues used in physical education and may provide additional evidence for the benefits of adopting either an internal or external focus of attention for young children.

CHAPTER 2

Methods

Participants

A total of 88 participants were recruited from intact physical education classes at a K-12 public school located in Tallahassee, Florida. A blocking method was used for skill level in which participants were randomly assigned to an internal focus group, external focus group or control group. Forty-three, nine and ten year old participants were randomly assigned as follows: 14 participants in the internal focus of attention group, 14 participants in the external focus of attention group and 15 participants in the control group. Forty-five, 11 and 12-year old participants were grouped as follows: 15 participants in the internal focus of attention group, 15 participants in the external focus of attention group and 15 participants in the control group. Considering the previous pilot data with children eight through 12 year olds the sample size was estimated. Using Cohen's d Formula with a pooled Standard Deviation for Effect Size $n = 2SD^2 (Z_{alpha,2} + Z_{beta})^2 / delta^2$ = subjects/group (Snedecor & Cochran, 1980). The required sample size to achieve Z_{beta} = .20 (80% power) with $Z_{alpha,2}$ = .05, (n-1) was 90 subjects or 15 subjects per group. Demographics for each group are presented in Table 1 and 2.

Table 1- Demographic Information for the 9 and 10 Year Olds

Age (Avg)	**Std Dev.**	**Height (in)**	**Std. Dev.**	**Weight (lbs)**	**Std. Dev.**
9.6 Years	.47	56.4	3.2	82.7	21.6

Table 2- Demographic Information for the 11 and 12 Year Olds

Age (Avg)	Std. Dev.	Height (in)	Std. Dev.	Weight (lbs)	Std. Dev.
11.3	1.00	60.2	3.97	111	27.6

Participants were not aware of the purpose of study. Prior to the study, each participant's parent signed an "Informed Consent Form", see Appendix A, and each participant signed a "Child Assent Form", see Appendix B. Florida State University's Committee for Protection of Human Subjects approved both forms prior to the study.

Instructional Set Groups

Internal Focus of Attention Group: The internal focus group was instructed to stand as still as possible while "keeping their feet still" on the platform during each 20-second testing trial. The experimenter gave the focus of attention instructions at the beginning of each trial.

External Focus of Attention Group: The external focus group was instructed to stand as still as possible while "keeping the platform still" during each 20-second testing trial. The experimenter gave the focus of attention instructions at the beginning of each trial.

Control Group: The control group was not given a focus condition. Instead the subjects were instructed to stand as still as possible. The experimenter gave these instructions at the beginning of each trial.

Apparatus

<u>Biodex Balance System</u>

All participants underwent a balance assessment using the Biodex Balance System; see Figure 5. The Biodex Balance System is divided into multiple balance tests. Each test can be calibrated to a specific stability level (level 1-least stable, level 8-most stable). The balance test used for this study was calibrated at level 3. Difficulty level was determined based on pilot data with college-age adults and children eight to 12 years old. Participant demographic information of height (in), weight (lbs) and age (yr) was entered into the program. Dependent variables measured were overall stability index, anterior/posterior stability index, medial/lateral stability index, mean deflection, anterior/posterior deflection and medial/lateral deflection, see "definition of terms", Chapter 1. The test duration for each trial was 20 seconds.

Figure 5. Biodex Balance System

Questionnaire

A short questionnaire consisting of two questions was given to participants to examine whether or not the participants were focusing on the specific focus of attention cue given by the experimenter; Appendix C.

Procedure

Pre-test Protocol

One week prior to testing, participants were introduced to the experimenter during their physical education classes at the Florida State University School. The “Informed Consent Form” and “Child Assent Form” were collected and participant demographic information of height (in), weight (lbs), and age (yr) were measured and recorded by the experimenter.

Next, each participant performed a simple balance task. Participants were instructed to perform the one-legged stand. The experimenter recorded the amount of time (# of seconds) each participant remained balanced until one leg touched the floor up to a maximum of four minutes. Two trials were given and the best trial was used to determine skill level. Skill level was determined by the group mean of each participant’s best trial (n≥two minutes = high skill level, n<two minutes = low skill level). Participants from skill level groups were randomly assigned to instructional set groups. The purpose of the balance task was to control for equal representation of skill level for each instructional set group. Random assignment of groups also included equal representation of gender. Demographic information was a part of the Biodex Balance System protocol and was entered in prior to instructional set trials and retention trials.

Testing Protocol

Upon entering the testing room at the Florida State University School, participants were re-introduced to the experimenter and then familiarized with the Biodex Balance System.

Prior to testing each participant was randomly assigned to an internal focus group, external focus group or control group (no focus). Participants were informed to hold on to the Biodex handrails and were instructed to find a center position on the platform. Once centered on the platform, masking tape was placed on the platform behind each heel. Masking tape was placed on the platform of the Biodex as a marker for the heel placement of each participant in order to insure consistency of heel placement at the beginning of each trial. Participant height (in), weight (lbs) and age were entered into the computerized program.

Next participants were instructed to maneuver the Biodex platform and move a cursor to the center of a target found on the computer screen. Once the cursor was in the target participants were instructed to maintain this position on the platform, without the use of the handrails for approximately 20 seconds. This condition was the first step to understanding how the platform moves; see Figure 6.

Figure 6. Participant Holding Cursor in the Center of the Target for 20 Seconds

Participants were given one practice trial consisting of the primary task of interest prior to any trials using a focus condition. Participants in each group completed six trials using either an internal or external focus condition or no focus condition. Participants in the internal focus group were instructed to stand as still as possible while “keeping their feet still” on the platform during each 20-second testing trial. Participants in the external focus group were instructed to stand as still as possible while “keeping the platform still” during each 20-second testing trial. The control group was not given a focus condition. Instead the participants were instructed to stand as still as possible. The experimenter gave instructions at the beginning of each trial for all groups. The test duration for each trial was 20 seconds.

Next, the Biodex computer screen was covered with a hand towel to eliminate visual feedback and the platform was released for the first of six instructional set trials; see Figure 7.

Figure 7. Participant Performing An Instructional Set Trial on the Biodex Balance System (Screen Covered)

Participants were instructed to hold onto the handrails and carefully step off the Biodex following each trial and stand in a designated area away from the testing area. The experimenter recorded the data for all dependent variables following each trial. Participants followed the same protocol for each trial and used the masking tape on the platform for heel replacement.

At the completion of the testing trials, each participant was given a short questionnaire. The purpose of the questionnaire was to examine whether or not participants were focusing on instructional set cues. However, for the control group the questionnaire examined what participants were “thinking about” during the testing and retention trials. The experimenter asked two questions to each participant and recorded all answers using a tape recorder.

Two days following the testing session a retention test was given. Each group completed three trials following the same testing protocol, however, no focus of attention instructions was given. The test duration for each retention trial was 20 seconds. An identical questionnaire used in the testing trials was given at the completion of the retention trials.

Approximately eight weeks were required to complete the instructional set trials and retention trials. Total testing time (instructional set trials and retention trials) for each participant was approximately 45 minutes.

Data Analysis

Dependent Variables

The dependent variables in this study included: overall stability, anterior/ posterior stability (a/p stability), medial/lateral stability (m/l stability), mean deflection, anterior/posterior deflection (a/p deflection) and medial/lateral deflection (m/l deflection). Scores for each dependent variable were computed by the Biodex Balance System following the six instructional set trials and three retention trials and was used for further analysis. A multivariate analysis of variance (MANOVA) was used to analyze the dependent variables drawn from the answers to the questionnaire. A univariate analysis of variance (ANOVA) was performed on significant individual dependent variables using the questionnaire data to determine which independent variables were significant for both instructional set trials and retention trials. For the control group this questionnaire examined what the participants were "thinking about" while performing the balance task.

Statistical Model

A three instructional set (internal focus group, external focus group and control group) x two age-group (nine and ten years olds and 11 and 12 year olds) x six trials with repeated measures on the last factor analysis of variance (ANOVA) was used to examine the effects of focus of attention following the six testing trials.

A three instructional set (internal focus group, external focus group and control group) x two age-group (nine and ten years olds and 11 and 12 year olds) x three trials with repeated measures on the last factor analysis of variance (ANOVA) was used to examine the effects of focus of attention following the three retention trials.

A multivariate analysis of variance (MANOVA) was used to analyze the questionnaire data as the independent variable for the following scenarios:

1) When given an external instructional set cue and used it, were they better in balance performance and learning than when given an internal instructional cue and used it?

Balance scores were examined by a two age group (9-10 year olds and 11-12 year olds) and instructional set cues (questionnaire results of given an external focus of attention cue and used it versus given an internal focus of attention cue and used it), multivariate analysis of variance (MANOVA) for six instructional set trials and three retention trials.

2) What were the effects of using an external cue versus an internal cue versus no cue for all groups?

Balance scores were examined by a two age group (9-10 year olds and 11-12 year olds) and instructional set cues (using an external cue versus using an internal cue versus using no cue), multivariate analysis of variance (MANOVA) for six instructional set trials and three retention trials.

3) What was the control group "thinking about" as they performed the balance task?

Balance scores were examined by a two age group (9-10 year olds and 11-12 year olds) and instructional set cues (using an external cue versus using an internal cue versus using no cue), for the control group only multivariate analysis of variance (MANOVA) for six instructional set trials and three retention trials.

After the MANOVA on all dependent variables, a univariate analysis of variance (ANOVA) was performed on significant individual dependent variables using the questionnaire data to determine which independent variables were significant for both instructional set trials and retention trials.

Alpha level will be set at .05 for all comparisons. Data analyses were performed using the computer statistical program SPSS 11.0 for Microsoft Windows.

CHAPTER 3

RESULTS

This study examined internal and external focus of attention as strategies for balance performance and learning in 9-12 year olds. Dependent variables measured were 1) overall stability, 2) anterior/posterior stability (a/p stability), 3) mean deflection, 4) medial/lateral stability (m/l stability), 5) anterior/posterior deflection (a/p deflection), and 6) medial/lateral deflection (m/l deflection). These dependent variables were organized in a three group (internal focus, external focus, and control group), two age group (9-10 year olds and 11-12 year olds) and six trials analysis of variance (ANOVA) with repeated measures on the last factor. For retention trials, dependent variables were organized in a three group (internal focus, external focus, and control group), two age group (9-10 year olds and 11-12 year olds) and three trials analysis of variance (ANOVA) with repeated measures on the last factor.

Effects of Focus of Attention Strategies and Age Groups on Balance Variables for Instructional Set Trials

Analysis of overall stability revealed a significant main effect for age category, $F(1,82) = 11.56$, $p = .001$. The nine and ten year olds resulted in less variation and better overall stability than 11-12 year olds, see Table 3 for means and standard deviations and Figure 8. There were no other significant main or interaction effects.

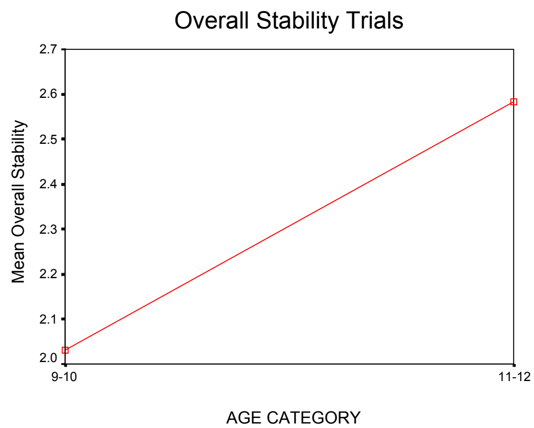

Figure 8. Overall Stability Trials (Age Category)

Analysis of anterior and posterior stability revealed a similar main effect as overall stability for age category, $F(1,82) = 9.47$, $p = .003$. The nine and ten year olds resulted in less variance in platform displacement in the sagittal plane than the 11-12 year olds, see Table 3 for means and standard deviations and Figure 9. Again, there were no other significant main or interaction effects.

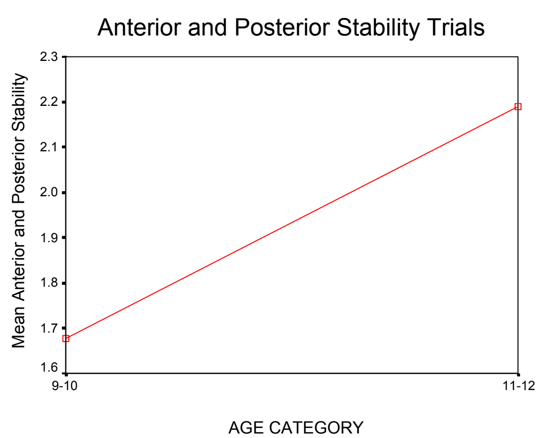

Figure 9. Anterior and Posterior Stability Trials (Age Category)

Analysis of mean deflection revealed one significant main effect for age category, $F(1,82) = 10.75$, $p = .002$, with no other significant effects. The nine and ten year olds resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds, see Table 3 for means and standard deviations and Figure 10.

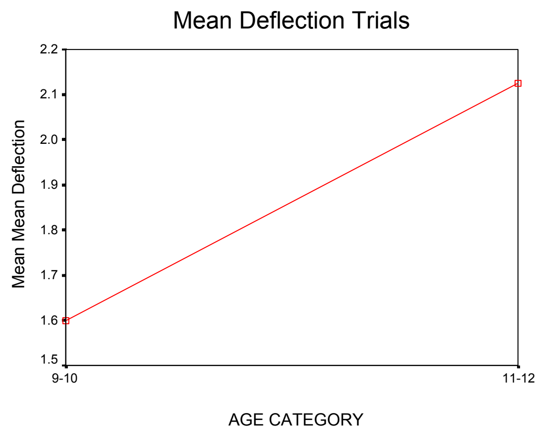

Figure 10. Mean Deflection Trials (Age Category)

Analysis of medial and lateral stability revealed a significant main effect for age category, $F(1,82)$, 4.65, $p = .034$. The nine and ten year olds resulted in less variance in platform displacement in the frontal plane than the 11-12 year olds, see Table 3 for means and standard deviations and Figure 11.

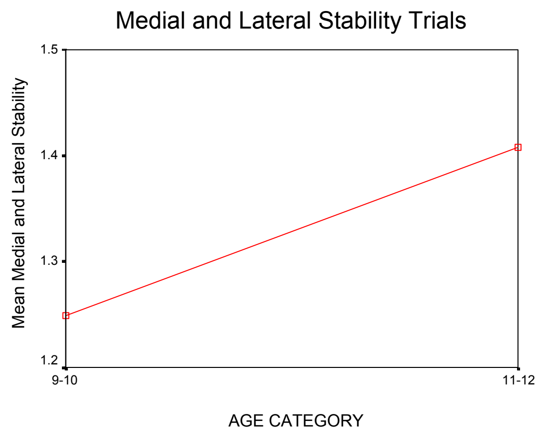

Figure 11. Medial and Lateral Stability Trials (Age Category)

Analysis of anterior and posterior deflection revealed a significant main effect for age category, $F(1,82) = 6.84$, $p = .011$. The nine and ten year olds were more centered in the sagittal plane than the 11-12 year olds, see Table 3 for means and standard deviations and Figure 12.

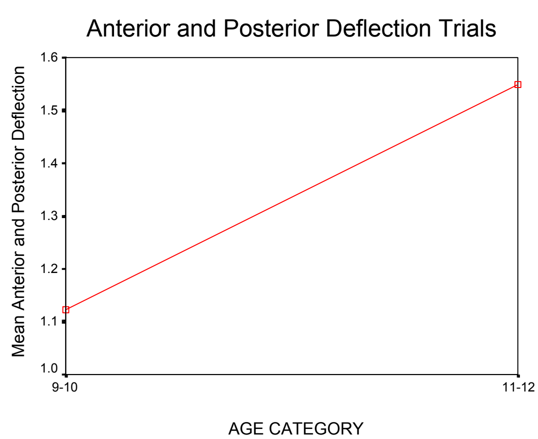

Figure 12. Anterior and Posterior Deflection Trials (Age Category)

Analysis of anterior and posterior deflection also revealed a three-way interaction between trials, focus group and age category, *F*(1,82) = 2.085, p= .025. According to Tukey HSD (1.07), the nine and ten year olds who used an external focus of attention demonstrated less variance and were more centered in the sagittal plane than the 11-12 year olds who used an internal focus of attention for instructional set trials four, five and six. In addition, the nine and ten year olds who used an internal focus of attention were better than 11-12 year olds who used an internal focus of attention for instructional set trials four, five and six, see Table 3 for means and standard deviations and Figure 13.

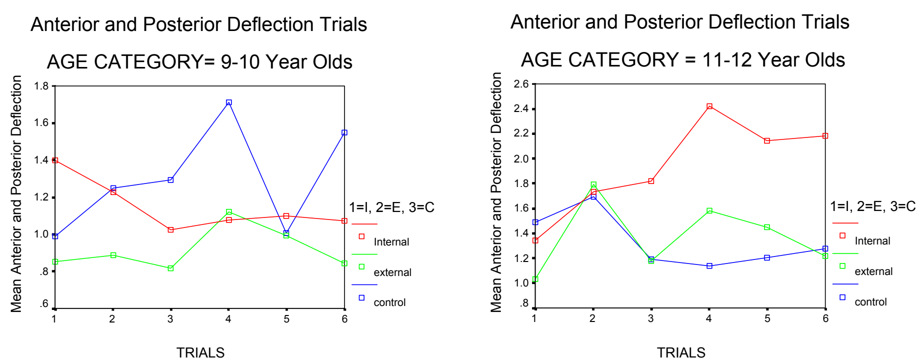

Figure 13. Three-Way Interaction Between Age, Attentional Focus and Trials-Anterior and Posterior Deflection Trials (9-12 Year Olds)

Analysis of medial and lateral deflection revealed no significant main or interactions effects.

Effects of Focus of Attention Strategies and Age Groups on Balance Variables for Retention Trials

Analysis of overall stability revealed a significant main effect for age category, *F*(1,82) = 7.87, p= .006. The nine and ten year olds resulted in less variation and better overall stability than 11-12 year olds, see Table 3 for means and standard deviations and Figure 14.

Figure 14. Overall Stability Retention Trials (Age Category)

Analysis of anterior and posterior stability revealed a significant main effect for age category, $F(1,82) = 6.92$, $p = .01$. The nine and ten year olds resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds, see Table 3 for means and standard deviations and Figure 15.

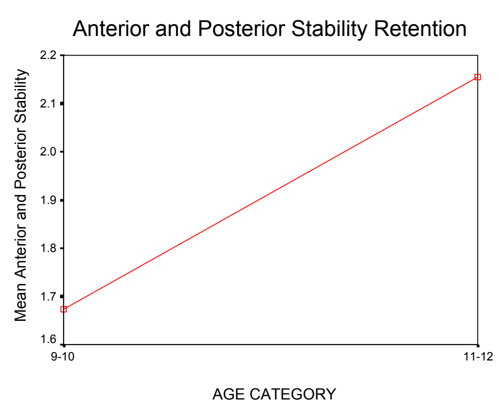

Figure 15. Anterior and Posterior Stability Retention Trials (Age Category)

Analysis of medial and lateral stability revealed a two-way interaction for focus group and age category, *F*(2,82) = 3.44, p= .037. According Tukey HSD (.38), the nine and ten year olds who used an external focus of attention demonstrated less variance in platform displacement in the frontal plane than the 11-12 year olds who used an external focus of attention and the control group, see Table 3 for means and standard deviations and Figure 16.

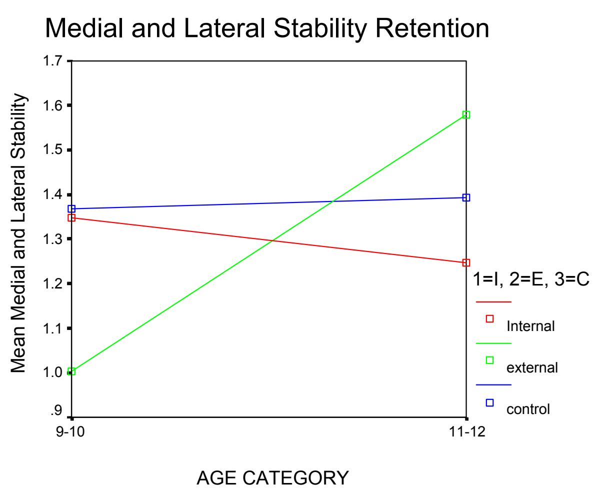

Figure 16. Two-Way Interaction Between Age and Focus Group- Medial and Lateral Stability Retention Trials

Analysis of mean deflection, anterior and posterior deflection, and medial and lateral deflection revealed no significant main effects or interactions.

Table 3-Means and Standard Deviations for the Effects of Focus of Attention Strategies and Age Groups On Balance Variables

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Overall Stability		9-10		Instructional Set	2.04	.67

Table 3-Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/ Cue	Trials	Means	Standard Deviation
Overall Stability		11-12			2.6	.86
Anterior and Posterior Stability		9-10		Instructional set	1.68	.65
		11-12			2.12	.91
Mean Deflection		9-10		Instructional set	1.60	.65
		11-12			2.12	.85
Medial and Lateral Stability		9-10		Instructional set	1.25	.34
		11-12			1.41	.35
Anterior and Posterior Deflection		9-10		Instructional set	1.13	.64
		11-12			1.54	.90
Anterior and Posterior Deflection		9-10		Trial 1	1.07	.82
				Trial 2	1.12	.95
				Trial 3	1.05	.85
				Trial 4	1.31	.96
				Trial 5	1.03	.95
				Trial 6	1.16	1.03
Anterior and Posterior Deflection		11-12		Trial 1	1.29	1.01
				Trial 2	1.74	1.22
				Trial 3	1.40	1.05
				Trial 4	1.71	1.46
				Trial 5	1.60	1.48
				Trial 6	1.56	1.31
Anterior and Posterior Deflection			Internal Group	Trial 1	1.37	.76
				Trial 2	1.49	1.11
				Trial 3	1.43	1.13
				Trial 4	1.77	1.46
				Trial 5	1.64	1.50
				Trial 6	1.64	1.50
Anterior and Posterior Deflection-Three-Way Interaction			External Group	Trial 1	.94	.89
				Trial 2	1.36	1.14
				Trial 3	1.00	.95
				Trial 4	1.36	1.15

Table 3- Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/ Cue	Trials	Means	Standard Deviation
Anterior and Posterior Deflection- Three-Way Interaction			External Group	Trial 5	1.23	1.11
				Trial 6	1.04	.65
Anterior and Posterior Deflection			Control Group	Trial 1	1.24	1.07
				Trial 2	1.47	1.19
				Trial 3	1.24	.78
				Trial 4	1.43	1.13
				Trial 5	1.11	1.16
				Trial 6	1.41	1.22
Overall Stability		9-10		Retention Trials	2.04	.58
		11-12			2.56	1.07
Anterior and Posterior Stability		9-10		Retention Trials	1.68	.56
		11-12			2.16	1.06
Medial and Lateral Stability=Two-Way Interaction		9-10		Retention Trials	1.24	.48
		11-12			1.41	.58
Medial and Lateral Stability= Two-Way Interaction			External Group	Retention Trials	1.3	.64
			Internal Group		1.3	.45
			Control Group		1.38	.53

Table 3A-Correlations for Weight, Height and Overall Stability

Dependent Variable	Independent Variable	Correlation =r	Means (Inches)	Standard Deviations
Overall Stability	Weight	r= .59, p= .001	97	27.6
	Height	r= .40, p= .001	58.3	3.97

Questionnaire Data as an Independent Variable Using Multivariate Analysis of Variance (MANOVA)

A questionnaire was given to examine what the participants were "thinking about" during the instructional set trials and retention trials. Questionnaire data were organized to examine specific questions relating to hypotheses one and two. A multivariate analysis of variance (MANOVA) analyzed the questionnaire data as the independent variable for the following scenarios:

1) When given an external instructional set cue and used it, were they better in balance performance and learning than when given an internal instructional cue and used it?

Balance scores were examined using a two age group (9-10 year olds and 11-12 year olds) and instructional set cues (questionnaire results of given an external focus instructional set cue and used it versus given an internal focus instructional set cue and used it), multivariate analysis of variance (MANOVA) for six instructional set trials and three retention trials.

2) What were the effects of using an external cue versus an internal cue versus no cue for all groups?

Balance scores were examined using a two age group (9-10 year olds and 11-12 year olds) and instructional set cues (using an external cue versus using an internal cue versus using no cue), multivariate analysis of variance (MANOVA) for six instructional set trials and three retention trials.

3) What was the control group "thinking about" as they performed the balance task?

Balance scores were examined using a two age group (9-10 year olds and 11-12 year olds) and instructional set cues (using an external cue versus using an internal cue versus using no cue), for the control group only multivariate analysis of variance (MANOVA) for six instructional set trials and three retention trials.

Questionnaire Data As An Independent Variable Using ANOVAs

After the MANOVA on all dependent variables, a univariate analysis of variance (ANOVA) was performed on significant individual dependent variables using the questionnaire data to determine which independent variables were significant for both instructional set trials and retention trials.

Effects of Giving an External Instructional Set Cue and Using It versus Giving an Internal Instructional Set Cue and Using It (Instructional Set Trials)

There were 20 out of 43 participants who were "given an external instructional set cue and then said they used it" versus 23 out of 43 participants who were "given an internal instructional set cue and said they used it". Only those participants who used their respective instructional set cues were used in this analysis.

Analysis of overall stability revealed main effects for age category and when "given an external focus cue and said they used it versus given an internal focus cue and said they used it", $F(1,39) = 11.047$, $p = .002$, $F(1,39) = 7.637$, $p = .009$, respectively. Nine and ten year olds demonstrated less variance and better overall stability than 11-12 year olds. Participants "given an external focus cue and said they used it" resulted in better overall stability than participants "given an internal focus cue and said they used it", see Table 4 for means and standard deviations and Figure 17 and 18 respectively.

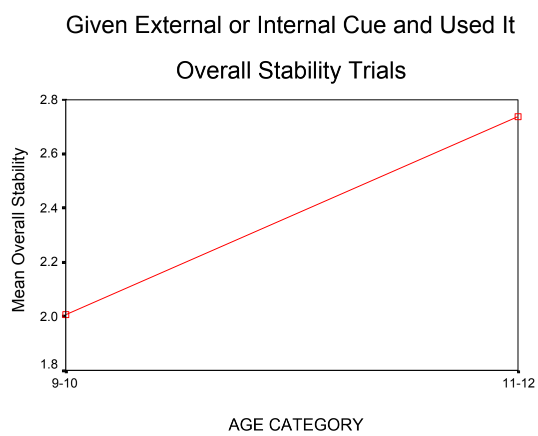

Figure 17. Given External Cue or Internal Cue and Used It- Overall Stability Trials (Age Category)

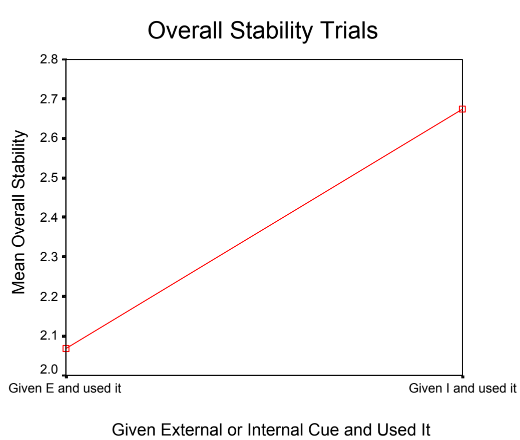

Figure 18. Given External Cue or Internal Cue and Used It- Overall Stability Trials (Focus of Attention)

A significant main effect for trials, $F(5,195) = 2.968$, $p = .013$, resulted in trial three being better than trials two, four, and five for overall stability. In addition, Tukey HSD (.44) resulted in trial six being better than trial four, see Table 4 for means and standard deviations and Figure 19.

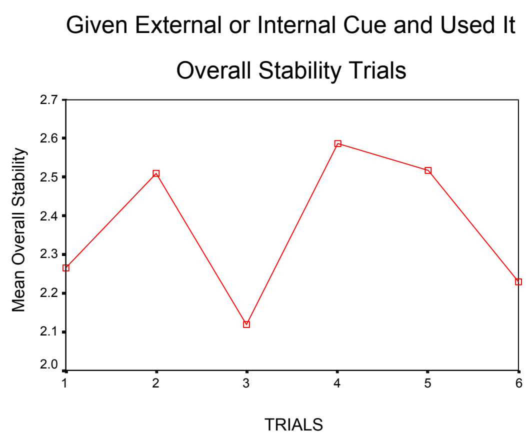

Figure 19. Given External Cue or Internal Cue and Used It- Overall Stability (Trials)

Analysis of anterior and posterior stability revealed significant main effects for age category and when "given external focus cue and said they used it versus given internal focus cue and said they used it", $F(1,39) = 12.138$, p= .001, $F(1,39) = 7.756$, p= .008, respectively. Nine and ten year olds resulted in less variance in platform displacement in the sagittal plane than the 11-12 year olds. Participants "given an external focus cue and said they used it" resulted in better anterior and posterior stability than participant "given an internal focus instructional set cue and said they used it". A significant main effect for trials, $F(5,195) = 3.392$, p= .006, resulted in trial three being better than trial four (.49), see Table 4 for means and standard deviations and Figures 20, 21, 22, respectively.

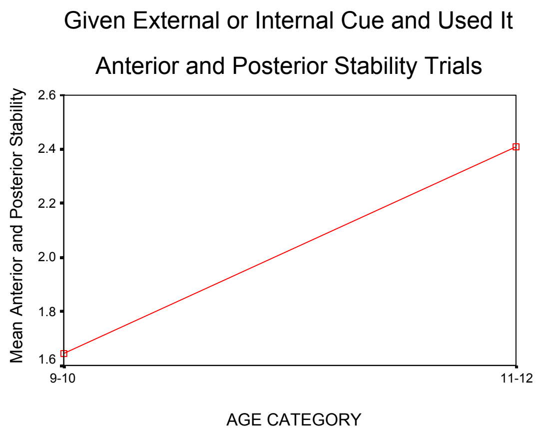

Figure 20. Given External Cue or Internal Cue and Used It- Anterior and Posterior Stability (Age Category)

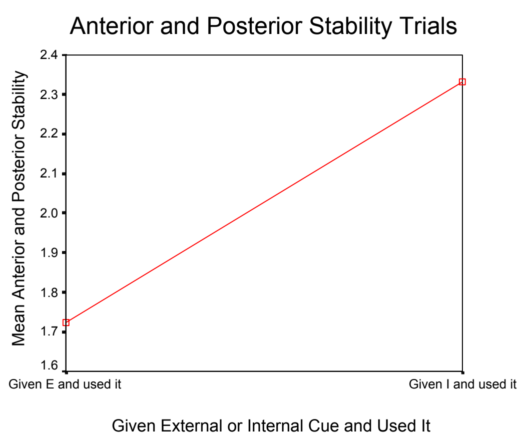

Figure 21. When Given External Cue or Internal Cue and Used It- Anterior and Posterior Stability Trials (Focus of Attention)

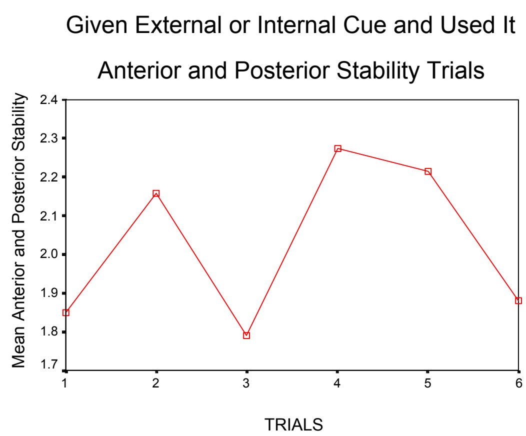

Figure 22. Given External Cue or Internal Cue and Used It- Anterior and Posterior Stability (Trials)

Analysis for anterior and posterior stability also resulted in a two-way interaction for age category and trials, $F(5,195) = 2.290$, $p = .047$. According to Tukey HSD (.734) the nine and ten year olds demonstrated less variance in platform displacement in the sagittal plane than the 11-12 year olds for trials two, four, five and six, see Table 4 for means and standard deviations and Figure 23.

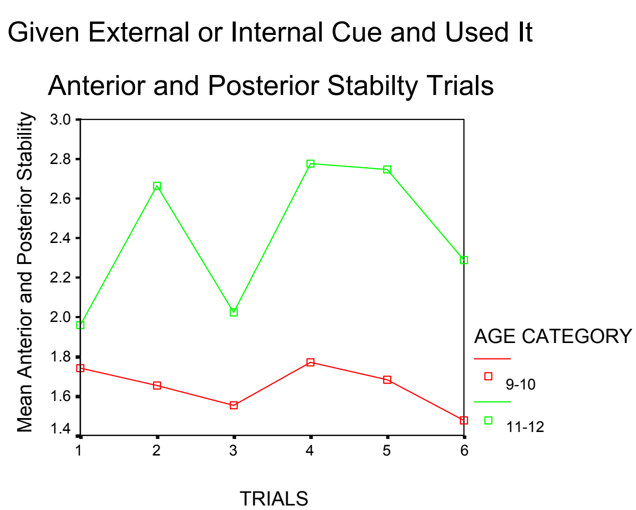

Figure 23. Two-Way Interaction Between Age and Trials When Given External or Internal Cue and Used It- Anterior and Posterior Stability Trials

Analysis of mean deflection resulted in significant main effects for age category and “given an external focus cue and said they used it versus given an internal focus cue and said they used it”, $F(1,39) = 10.759$, $p = .002$ and $F(1,39) = 6.767$, $p = .013$, respectively. Nine and ten year olds resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds. Participants “given an external focus cue and said they used it” resulted in better mean deflection than participants “given an internal focus cue and said they used it”, see Table 4 for means and standard deviations and Figures 24 and 25, respectively.

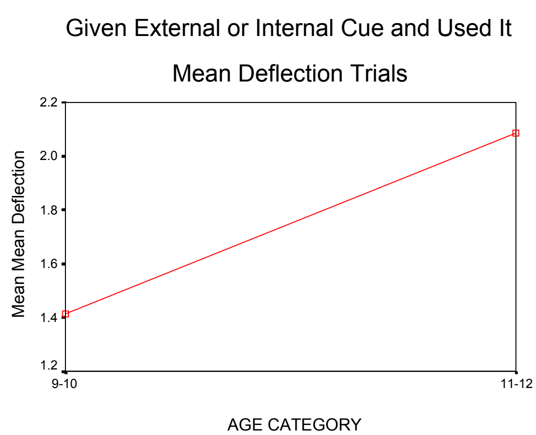

Figure 24. Given External Cue or Internal Cue and Used It- Mean Deflection Trials

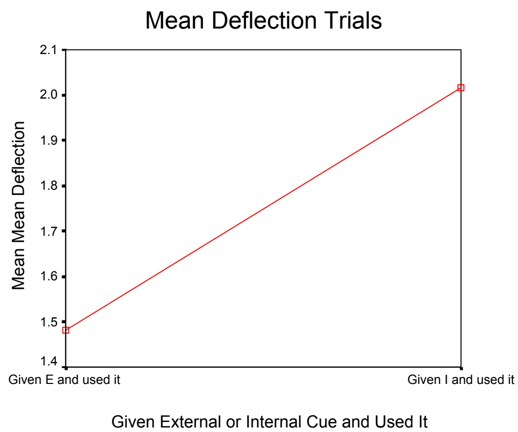

Figure 25. Given External Cue or Internal Cue and Use It- Mean Deflection Trials (Focus of Attention)

Analysis of mean deflection also resulted in a significant main effect for trials, *F*(5,195) = 20.854, p= .000. According to Tukey HSD (.39), subjects during trial one demonstrated more neuromuscular control to remain centered on the platform than in trials two, three, four, five and six. Trial three was also better than trials two, four and five, see Table 4 for means and standard deviations and Figure 26.

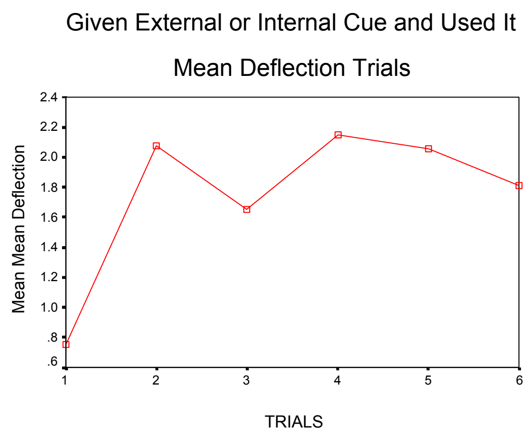

Figure 26. Given External Cue or Internal Cue and Used It- Mean Deflection (Trials)

Additional analysis of mean deflection resulted in a significant two-way interaction for age category and trials, $F(5,195) = 2.654$, $p = .024$. According to Tukey HSD (.734), nine and ten year olds resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds in trials two, four, five and six, see Table 4 for means and standard deviations and Figure 27.

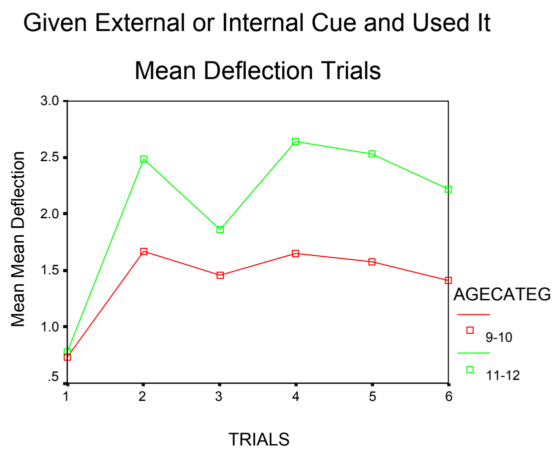

Figure 27. Two-Way Interaction Between Age and Trials When Given External or Internal Cue and Used It- Mean Deflection Trials

Analysis of anterior and posterior deflection revealed significant main effects for age category and when "given external focus cue and said they used it versus given internal focus cue and said they used it", $F(1,39) = 8.827$, $p = .005$ and $F(1,39) = 7.862$, $p = .008$, respectively. The nine and ten year olds were more centered in the sagittal plane than the 11-12 year olds. Participants "given an external focus cue and said they used it" resulted in better anterior and posterior deflection than participants "given an internal focus cue and said they used it." A significant main effect for trials, $F(5,195) = 2.469$, $p = .034$, resulted in trial three being better than trial four (HSD .52) see Table 4 for means and standard deviations and Figure 28, 29, 30, respectively.

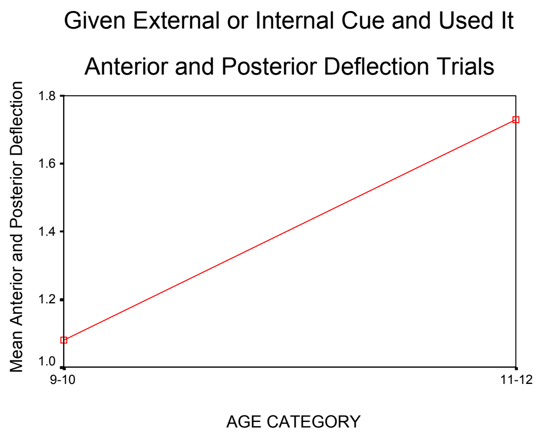

Figure 28. Given External Cue or Internal Cue and Used It- Anterior and Posterior Deflection Trials (Age Category)

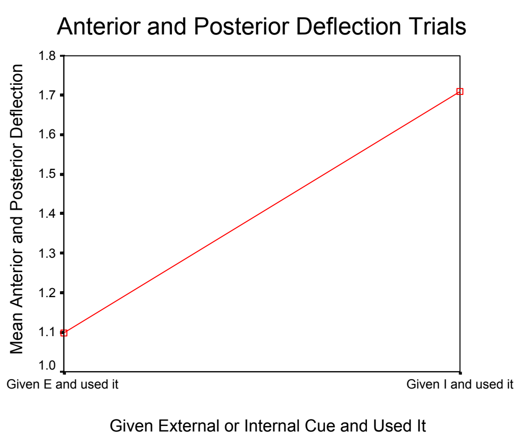

Figure 29. Given External Cue or Internal Cue and Use It- Anterior and Posterior Deflection Trials (Focus of Attention)

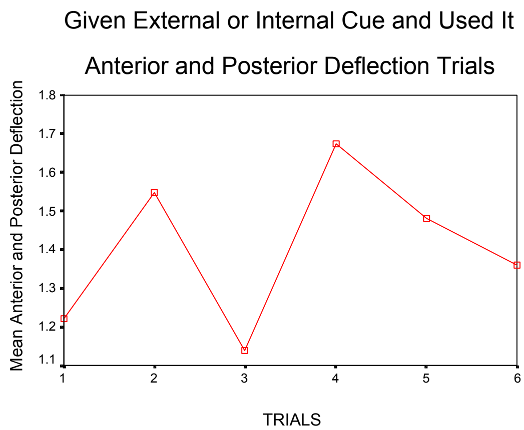

Figure 30. Given External Cue or Internal Cue and Used It- Anterior and Posterior Deflection (Trials)

Further analysis of anterior and posterior deflection revealed a three-way interaction for trials, age category and when "given external focus cue and said they used it versus given an internal focus cue and said they used it", $F(5,195) = 2.4$, $p = .039$. According to Tukey HSD (.475), nine and ten year olds when "given external focus cue and said they used it" were more centered in the sagittal plane than nine and ten year olds "given an internal focus cue and said they used it", for trials one and two. Nine and ten year olds when "given external focus cue and said they used it" were better than the 11-12 year olds "given an internal focus cue and said they used it" for all trials. Eleven and twelve year olds when "given external focus cue and said they used it" were better than the nine and ten year olds and 11-12 year olds "given an internal focus cue and said they used it" for trial one, see Table 4 for means and standard deviations and Figure 31.

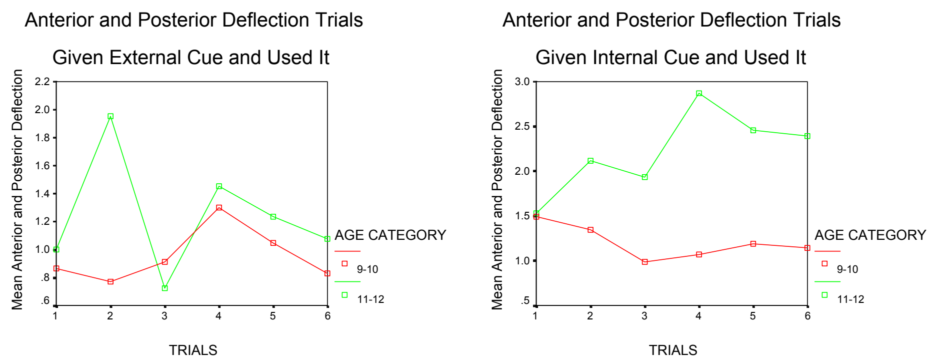

Figure 31. Three-Way Interaction Between Age, Given External Cue and Use It Retention Trials- Anterior and Posterior Deflection (9-12 Year Olds)

Analysis of medial and lateral stability, medial and lateral deflection revealed no significant main effects or interactions. Based on the analyses above hypothesis one and hypothesis two are accepted. Nine and ten year olds and 11-12 year olds did benefit in balance performance and learning when they adopted an external focus of attention.

Effects of Giving an External Instructional Set Cue and Using It versus Giving an Internal Instructional Set Cue and Using It (Retention Trials)

Analysis of medial and lateral stability revealed a three-way interaction for retention trials, age category and when “given external focus cue and said they used it versus given an internal focus cue and said they used it”, $F(2,78) = 3.865$, $p= .025$. According to Tukey HSD (.38), nine and ten year olds when “given external focus cue and said they used it” demonstrated less variance in platform displacement in the frontal plane than the nine and ten year olds “given an internal focus cue and said they used it” for trials two and three. Nine and ten year olds when “given external focus cue and said they used it” were better than the 11-12 year olds “given external focus cue and said they used it” for all retention trials and the 11-12 year olds “given an internal focus cue and said they used it” for retention trials one and two. Eleven and twelve year olds “given an internal focus cue and said they used it" were better than the 11-12 year olds "given external focus cue and said they used it" for trials two and three, see Table 4 for means and standard deviations and Figure 32.

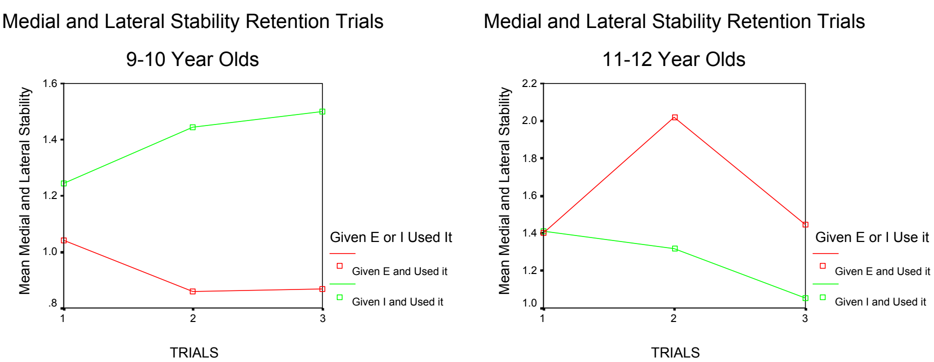

Figure 32. Three-Way Interaction Between Age, Given External Cue or Internal Cue and Used It Retention Trials- Medial and Lateral Stability (9-12 Year Olds)

Further analysis of medial and lateral stability revealed a significant two-way interaction for age category and"given external focus cue and said they used it versus given an internal focus cue and said they used it", $F(1,39)= 6.425$, $p=.015$. Although F was significant according to Tukey HSD (1.06) there were no significant pairwise means, see Table 4 for means and standard deviations and Figure 33.

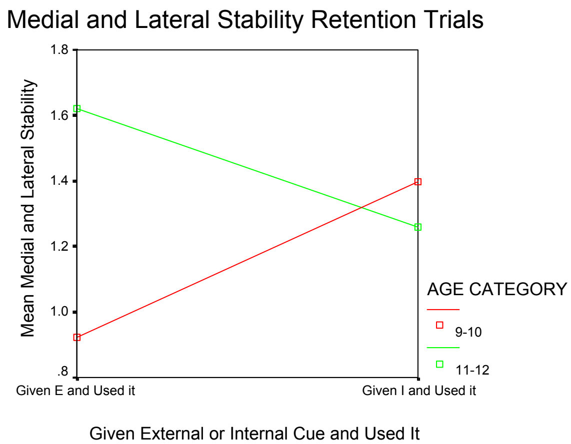

Figure 33. Two-Way Interaction Between Age and Given External or Internal and Used It-Medial and Lateral Stability Retention Trials

Analysis of overall stability, anterior and posterior stability, mean deflection, anterior and posterior deflection, and medial and lateral deflection revealed no significant main effects or interactions.

Table 4-Means and Standard Deviations for Effects of Giving an External Focus Cue or Internal Focus Cue and Using It

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Overall Stability	Given External or Internal Cue and Used It	9-10			2.02	.68
		11-12			2.77	.85

Table 4-Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Overall Stability	Given External or Internal Cue and Used It		External Cue and Used It		2.04	.62
Overall Stability				Instructional set 1	2.27	.83
				2	2.5	1.03
				3	2.13	.86
				4	2.6	1.29
				5	2.52	1.24
				6	2.22	1.17
Anterior and Posterior Stability= Two-Way Interaction	Given External or Internal Cue and Used It	9-10		Instructional Set Trials 1	1.75	.77
				2	1.66	.77
				3	1.56	.76
				4	1.8	.77
				5	1.69	1.02
				6	1.48	.92
				6	2.3	1.33
Mean Deflection Trials	Given External or Internal Cue and Used It	9-10			1.42	.67
		11-12			2.31	.86
Mean Deflection Trials	Given External or Internal Cue and Used It		External Cue and Used It		1.48	.61
			Internal Cue and Used It		2.02	.92
Mean Deflection Trials	Given External or Internal Cue and Used It			Instructional Set Trials 1	.75	.66
				2	2.06	1.04
				3	1.67	.84
				4	.76	.57
				5	2.06	1.25
				6	1.81	1.15
Mean Deflection Trials= Two-Way Interaction	Given External or Internal Cue and Used It	9-10		Instructional Set Trials 1	.87	.81
				2	1.68	.87
				3	1.50	.78
				4	1.65	.83
				5	1.58	.98
				6	1.41	.87

Table 4- Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Mean Deflection Trials= Two-Way Interaction	Given External or Internal Cue and Used It			Instructional Set Trials 1	.91	.82
				2	2.49	1.07
				3	1.91	.87
				4	2.70	1.45
				5	2.60	1.32
				6	2.3	1.28
Anterior and Posterior Deflection	Given External or Internal Cue and Used It	9-10			1.10	.62
		11-12			1.78	.93
Anterior and Posterior Deflection	Given External or Internal Cue and Used It		External Cue and Used It		1.08	.59
			Internal Cue and Used It		1.70	.94
Anterior and Posterior Deflection	Given External or Internal Cue and Used It			Instructional Set Trials 1	1.24	.85
				2	1.52	1.15
				3	1.16	.95
				4	1.67	1.37
				5	1.49	1.28
				6	1.37	1.22
Anterior and Posterior Deflection=Three-Way Interaction	Given External or Internal Cue and Used It		External Cue and Used It	Instructional Set Trials 1	.92	.83
				2	1.3	1.16
				3	.83	.46
				4	1.37	1.26
				5	1.13	.94
				6	.94	.65
			Internal Cue and Used It	Instructional Set Trials 1	1.5	.79
				2	1.71	1.13
				3	1.44	1.16
				4	1.93	1.44
				5	1.8	1.7
				6	1.47	1.47

Table 4- Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Anterior and Posterior Deflection=Three-Way Interaction	Given External or Internal Cue and Used It	9-10		Instructional Set Trials 1	1.19	.84
				2	1.07	.82
				3	.95	.76
				4	1.18	.71
				5	1.12	.97
				6	.99	.92
Anterior and Posterior Deflection= Three-Way Interaction	Given External or Internal Cue and Used It	11-12		Instructional Set Trials 1	1.29	.88
				2	2.05	1.27
				3	1.39	1.10
				4	2.23	1.72
				5	1.90	1.48
				6	1.80	1.40
Medial and Lateral Stability= Three-Way Interaction	Given External or Internal Cue and Used It	9-10		Retention Trials 1	1.13	.70
				2	1.11	.68
				3	1.14	.74
	Given External or Internal Cue and Used It	11-12		Retention Trials 1	1.40	.67
				2	1.67	.70
				3	1.25	.66
Medial and Lateral Stability= Three-Way Interaction			External Cue and Used It	Retention Trials 1	1.21	.77
				2	1.41	.92
				3	1.14	.73
			Internal Cue Used It	Retention Trials 1	1.33	.60
				2	1.38	.47
				3	1.26	.65

Table 4- Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Medial and Lateral Stability= Two-Way Interaction	Given External or Internal Cue and Used It	9-10			1.23	.42
		11-12			1.41	.34
			External Cue Used it		1.15	.43
			Internal Cue Used		1.42	.36

Effects of Using an External Cue versus Using an Internal Cue versus Using No Cue for All Groups (Instructional Set Trials)

This analysis examined using an external cue versus internal cue or no cue regardless of what instructional set group participants were assigned. All participants were used in this analysis. However, for this analysis a participant could be given an external focus cue, for example, but then used an internal focus cue. This analysis is based on what focus cue they actually used, not what they were given, see Table 5.

Table 5-Focus Cue Given and Focus Cue Used

Group	Age Category	Cue Given	# of Participants	Cue Used	# of Participants
External	9-10	External	14	External Internal	11 3
Internal	9-10	Internal	14	Internal External	12 2
Control	9-10	No Cue	15	Internal External Nothing	6 4 5
External	11-12	External	15	External Internal	9 6
Internal	11-12	Internal	15	Internal External	11 4
Control	11-12	No Cue	15	Internal External Nothing	5 9 1

Analysis of overall stability revealed significant main effects for age category and cue, $F(1,82) = 8.548$, $p = .004$ and $F(2,82) = 3.107$, $p = .05$, respectively. Nine and ten year olds demonstrated less variance and better overall stability than 11-12 year olds. According to Tukey HSD (.413), participants who used an external focus cue were better than subjects who used an internal focus cue, see Table 6 for means and standard deviations and Figures 34 and 35, respectively.

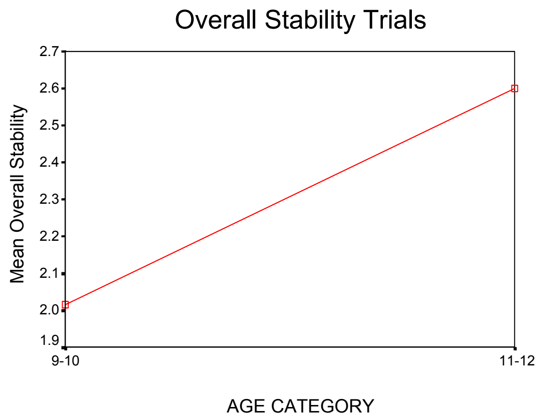

Figure 34. Nine and Ten Year Olds Vs. 11-12 Year Olds- Overall Stability Trials (Age Category)

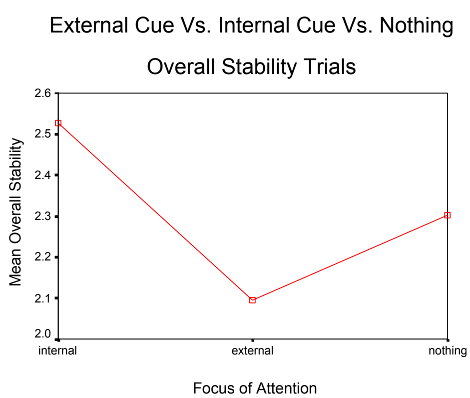

Figure 35. External Cue Vs. Internal Cue Vs. No Cue- Overall Stability Trials (Focus of Attention Cue)

Analysis of anterior and posterior stability revealed significant main effects for age category and cue used, $F(1,82) = 6.427$, p= .013 and $F(2,82) = 4.317$, p= .017, respectively. Nine and ten year olds resulted in less variance in platform displacement in the sagittal plane than the 11-12 year olds. According to Tukey HSD (.417), participants who used an external focus cue were better than participants who used an internal focus cue, see Table 6 for means and standard deviations and Figures 36 and 37, respectively.

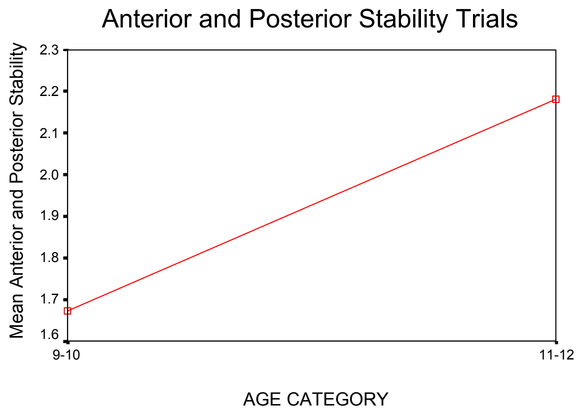

Figure 36. Nine and Ten Year Olds Vs. 11-12 Year Olds- Anterior and Posterior Stability Trials (Age Category)

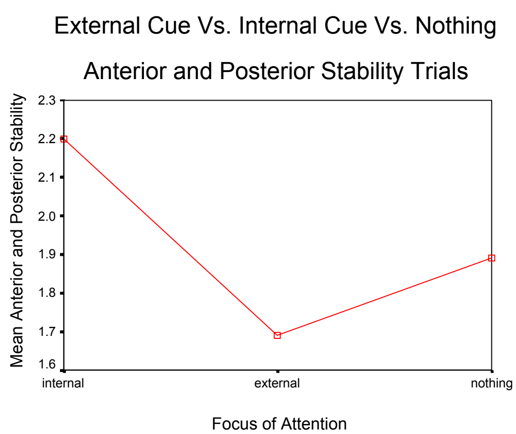

Figure 37. External Cue Vs. Internal Cue Vs. No Cue- Anterior and Posterior Stability Trials (Focus of Attention)

Analysis of medial and lateral stability revealed a significant effect for age category, $F(1,82) = 5.372$, p= .023. The nine and ten year olds resulted in less variance in platform displacement in the frontal plane than the 11-12 year olds, see Table 6 for means and standard deviations and Figure 38.

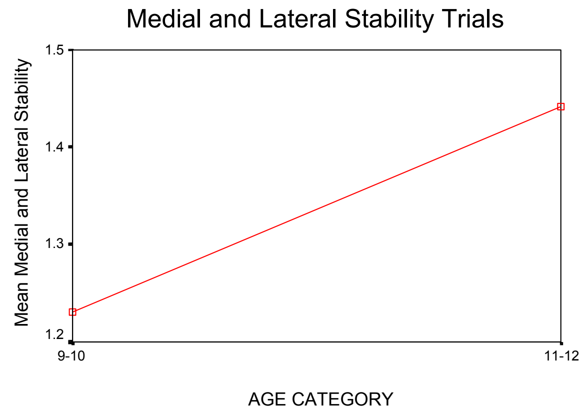

Figure 38. Nine and Ten Year Olds Vs. 11-12 Year Olds- Medial and Lateral Stability Trials (Age Category)

Analysis of mean deflection revealed a significant main effect for age category, $F(1,82) = 7.891$. The nine and ten year olds resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds, see Table 6 for means and standard deviations and Figure 39.

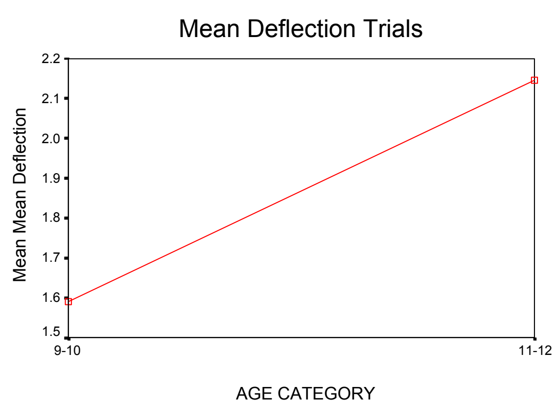

Figure 39. Nine and Ten Year Olds Vs. 11-12 Year Olds - Mean Deflection Trials (Age Category)

Analysis of anterior and posterior deflection revealed significant main effects for age category and cue used, $F(1,82) = 5.118$, $p = .026$ and $F(2,82) = 3.880$, $p = .025$, respectively. Nine and ten year olds were more centered on the platform in the sagittal plane than 11-12 year olds. According to Tukey HSD (.41), participants who used an external focus cue were better than participants who used an internal focus cue, see Table 6 for means and standard deviations and Figures 40 and 41, respectively.

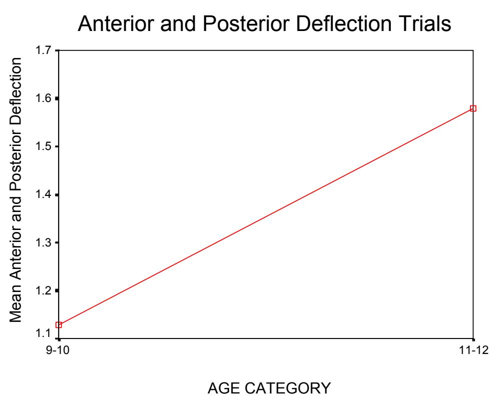

Figure 40. Nine and Ten Year Olds Vs. 11-12 Year Olds - Anterior and Posterior Deflection Trials (Age Category)

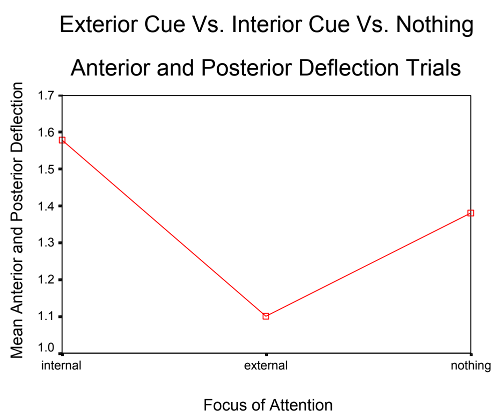

Figure 41. External Cue Vs. Internal Cue Vs. Nothing- Anterior and Posterior Deflection Trials (Focus of Attention)

Analysis of medial and lateral deflection revealed no significant main effects or interactions. Based on the analyses above hypothesis one and hypothesis two are accepted. Nine and ten year olds and 11-12 year olds did benefit in balance performance and learning when they adopted an external focus of attention.

Effects of Using an External Cue versus Using an Internal Cue versus Using No Cue For All Groups (Retention Trials)

Analysis of medial and lateral stability revealed a two-way interaction for age category and cue used, $F(2,82) = 4.960$, $p = .009$. According to Tukey HSD (.54), nine and ten year olds who used an external focus cue resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds who used no cue. Eleven and 12 year olds who used an internal focus cue were better than 11-12 year olds who used no cue, see Table 6 for means and standard deviations and Figure 42.

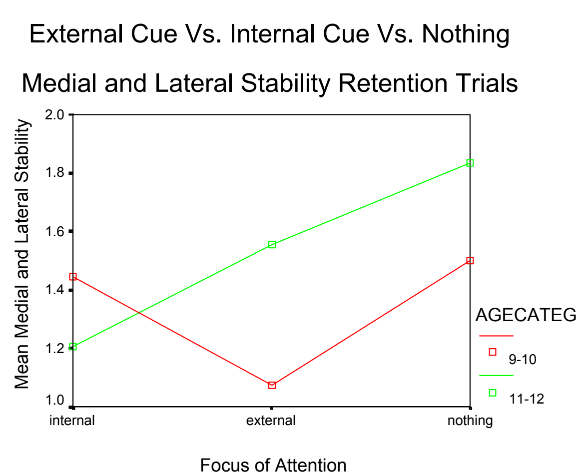

Figure 42. Two-Way Interaction Between Age and Focus of Attention Cue- Medial and Lateral Stability Retention Trials

Further analysis of variance (ANOVA) revealed no significant main effects or interaction effects for overall stability, anterior and posterior stability, mean deflection, anterior and posterior deflection and medial and lateral deflection.

Table 6-Means and Standard Deviation for Effects of Using an External Focus Cue Vs. Internal Focus Cue Vs. No Cue

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Overall Stability	External Cue Vs. Internal Cue Vs. No Cue		External Cue		2.13	.70
			Internal Cue		2.52	.88
			No Cue		2.24	.89
	External Cue Vs. Internal Cue Vs. No Cue	9-10			2.04	.67
		11-12			2.60	.86
Anterior and Posterior Stability	External Cue Vs. Internal Cue Vs. No Cue		External Cue		1.71	.71
			Internal Cue		2.20	.90
			No Cue		1.85	.79
Anterior and Posterior Stability	External Cue Vs. Internal Cue Vs. No Cue	9-10			1.68	.65
		11-12			2.12	.91
Medial and Lateral Stability	External Cue Vs. Internal Cue Vs. No Cue	9-10			1.25	.34
		11-12			1.41	.35
Mean Deflection	External Cue Vs. Internal Cue Vs. No Cue	9-10			1.60	.65
		11-12			2.12	.85

Table 6- Continued

Dependent Variable	Independent Variable	Age Category	Focus Group/Cue	Trials	Means	Standard Deviation
Anterior and Posterior Deflection	External Cue Vs. Internal Cue Vs. No Cue		External Cue		1.11	.71
			Internal Cue		1.59	.88
			No Cue		1.34	.72
Anterior and Posterior Deflection	External Cue Vs. Internal Cue Vs. No Cue	9-10			1.13	.64
		11-12			1.54	.90
Medial and Lateral Stability= Two-Way Interaction		9-10			1.23	.42
		11-12			1.41	.34
				External Cue	1.31	.59
				Internal Cue	1.31	.47
				No Cue	1.57	.44

Effects of Using an External Cue versus an Internal Cue versus No Cue Retention Trials (Control Group Only)

Analysis of overall stability revealed a significant three-way interaction for retention trial, age category and cue used, $F(2,50) = 3.996$, $p = .025$. According to Tukey HSD (HSD .45), nine and ten year olds who used an external focus cue demonstrated less variance and better overall stability than participants who used no cue in trial one. Nine and ten year olds who used an external focus cue were better than 11-12 year olds who used an internal or external focus cue for trial one. Nine and ten year olds who used an external focus cue were better than nine and ten year olds who used an internal focus cue or who used no cue for trial two. Nine and ten year olds who used an external focus cue were better than 11-12 year olds who used an internal or external focus cue in trial two. Nine and ten year olds who used an external focus cue were better than nine and ten year olds who used no cue and 11-12 year olds who used an internal focus cue in trial three, see Table 7 for means and standard deviations and Figure 43. Also, you can observe that there were no 11-12 year olds who used "nothing" as their cue for the retention trials.

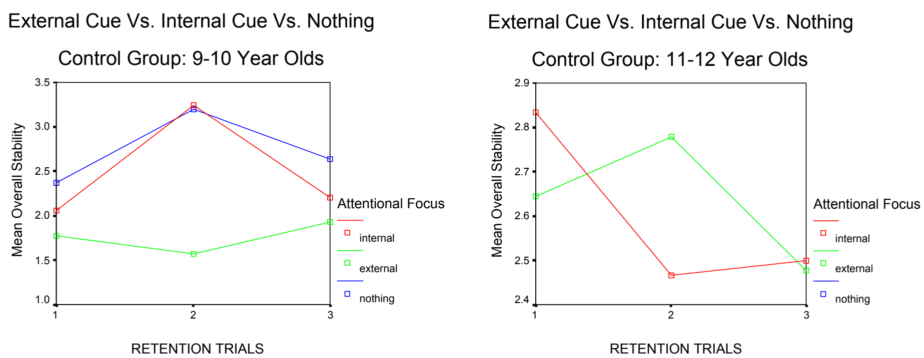

Figure 43. Three-Way Interaction Between Age, Focus of Attention and Trials- Overall Stability Retention Trials (9-12 Year Olds)

Table 7-Means and Standard Deviations for Effects of Using an External Focus Cue Vs. Internal Focus Cue Vs. No Cue (Control Group Only)

Dependent Variable	Independent Variable	Age Category	Focus Group	Trials	Means	Standard Deviation
Overall Stability- Three-Way Interaction Retention	External Cue Vs. Internal Cue Vs. No Cue			Retention Trials 1	1.99	.52
				2	2.45	1.23
				3	2.16	.69
Overall Stability- Three-Way Interaction Retention				Retention Trials 1	2.72	1.17
				2	2.65	1.17
				3	2.55	1.19
Overall Stability- Three-Way Interaction Retention	External Cue Vs. Internal Cue Vs. No Cue		External Cue	Retention Trials 1	2.26	1.23
				2	2.25	1.25
				3	2.24	1.20

Table 7- Continued

Dependent Variable	Independent Variable	Age Category	Focus Group	Trials	Means	Standard Deviation
Overall Stability- Three-Way Interaction Retention			Internal Cue	Retention Trials 1	2.48	.63
				2	2.81	1.18
				3	2.36	.69
			No Cue	Retention Trials 1	2.40	.21
				2	3.2	0
				3	2.6	.75
Overall Stability- Three-Way Interaction Retention	External Cue Vs. Internal Cue Vs. No Cue	9-10			2.13	.70
		11-12			2.52	.88

CHAPTER 4

SUMMARY, DISCUSSION, CONCLUSIONS, AND IMPLICATIONS FOR FUTURE RESEARCH

Summary and Discussion

The results of the present study extend the previous findings showing the benefits of an external focus of attention (Shea & Wulf, 1999, Wulf et. al, 1998,1999) to the performance and learning of a balance task for children. While previous studies compared the effectiveness of an external focus relative to an internal focus on balance using adult participants, the present study attempted to identify the benefits of using an external focus of attention for nine through 12 year olds. In addition, the present study attempted to explore the internal processes of what nine through 12 year olds were "thinking about" when given instructional focus cues during a dynamic balance task and if balance learning has occurred when "thinking about" the instructional set cue during the retention trials. The present study attempts to contribute to previous studies by including two control groups, one for nine and ten year olds and one for 11-12 year olds. The control groups were not provided an instructional focus cue, however, a short questionnaire examined what they were "thinking about" while performing the dynamic balance task. Lastly, the present study attempts to show evidence of the benefits of adopting an external focus of attention and its application to teaching motor skills in physical education.

The hypotheses of the present study were established to provide answers for the benefits of using an external focus of attention during a dynamic balance task. The first hypothesis for the nine and ten year old age groups stated that instructions referring to an external focus of attention will be more effective in balance performance and learning than internal focus instructions. The second hypothesis for the 11-12 year old age groups stated that instructions referring to an external focus of attention will be more effective in balance performance and learning than internal focus instructions. Results of the experiment provide the following support for these hypotheses.

According to Wulf et. al. (2002), instructions that direct the learner's attention to his or her body movements (internal) are not as effective as those instructions directing the learner's attention to his or her movement effects (external focus). The results of the present questionnaire when participants were "given an external focus cue and said they used it" were more effective in balance performance and learning than when they were "given an internal cue and said they used it".

Analysis of overall stability, a/p stability, mean deflection, and a/p deflection revealed that nine and ten year olds when "given an external cue and said they used it" in the questionnaire demonstrated less variance in platform displacement and better overall stability than nine and ten year olds "given an internal cue and said they used it". Eleven and 12 year olds when "given an external cue and said they used it" demonstrated less variance in platform displacement and better overall stability than 11-12 year olds "given an internal cue and said they used it" for instructional set trials.

Further analysis for a/p stability and mean deflection revealed that the nine and ten year olds "when given an external cue or an internal cue and said they used it" demonstrated less variance in platform displacement in the sagittal plane and remained more centered than the 11-12 year olds for instructional set trials two, four, five and six.

Further analysis of a/p deflection revealed that nine and ten year olds when "given an external cue and said they used it" were more centered in the sagittal plane than nine and ten year olds "given an internal cue and said they used it" for instructional set trials one and two. Nine and ten year olds when "given an external cue and said they used it" were better than the 11-12 year olds "given an internal cue and said they used it" for all instructional set trials. Eleven and 12 year olds "when given an external cue and said they used it" were better than the nine and ten year olds "given an internal cue and said they used it" for all instructional set trials.

During the retention trials analysis of m/l stability revealed that nine and ten year olds “when given an external cue and said they used it” demonstrated less variance in platform displacement in the frontal plane than the nine and ten year olds “given an internal cue and said they used it” for trials two and three. Nine and ten year olds “when given an external cue and said they used it” were better than the 11-12 year olds “when given an external or an internal cue and said they used it” for all trials.

These results for participants “when given an external cue and said they used it” adds to the growing support for the “constrained-action hypothesis” to account for the benefits of an external focus of attention. According to this hypothesis performer’s who focus on their body movements have the tendency to intervene more with the control of their movements compared to those performer’s who focus on an external effect. Performer’s who intervene with the automatic control processes of the movement tend to degrade what would normally regulate their body movement. Participants in this study who were “given an external cue and said they used it” apparently allowed their unconscious or lower levels to process and control their movements resulting in better balance performance and learning (McNevin, Wulf & Shea, 1999).

The results below are based on the attentional focus cue participants said they used while performing the balance task, not necessarily the focus cue they were given, since the control groups were not provided a focus cue. The questionnaire results examined what the participants were “thinking about” when they were performing the balance task during the instructional set trials and retention trials. Therefore, all three groups were included in these analyses and a participant was categorized by what cue they used, not by what they were provided. For example, participants provided an internal focus cue might have said they used an external focus cue therefore they would be in the external group in this analysis. Likewise, participants in the control groups might have said they used an external focus cue and they were categorized into the external group for the following discussion.

Analysis of overall stability, a/p stability and a/p deflection revealed that nine and ten year olds who used an external focus cue demonstrated less variance and better overall stability, a/p stability and a/p deflection than nine and ten year olds who used an internal focus cue for instructional set trials. Eleven and 12 year olds who used an external focus cue demonstrated less variance and better overall stability, a/p stability and a/p deflection than 11-12 year olds who used an internal focus cue for instructional set trials.

Analysis of m/l stability revealed nine and ten year olds who used an external cue resulted in more neuromuscular control to remain centered on the platform than 11-12 year olds who used no cue for retention trials. Eleven and 12 year olds who used an internal cue were better than 11-12 year olds who used no cue for retention trials.

These results add to previous studies as well as to the analyses discussed above on cues provided and said they used them. For example, Wulf et. al. (2003) asked participants to keep a ball in the center of a small wooden tube and then direct their attention to either external or internal focus conditions. The external focus condition directed the participants to keep the tube horizontal, the internal focus condition directed the participants to keep their hands horizontal while balancing on the stabilometer. The number of times the ball made contact with either side of the wooden tube was measured for the supra-postural task. On day three, a retention test was given for four trials in which no focus of attention instructions were provided. A transfer test consisting of three trials was given without the wooden tube. More effective learning took place as a result of external focus of attention. The results were the same for the transfer test when the tube was removed. The findings from the transfer test showed the importance of external focus on the performance of a postural control task as well as the learning effect of a new balance task.

In the current analysis nine and ten year olds who adopted an external focus of attention were better in balance performance than those who used an internal cue for instructional set trials. Nine and ten year olds who used an external focus cue learned to balance better than 11-12 year olds who used no cue in the retention trials.

This study also attempted to examine what participants in the control groups were “thinking about”, by using a questionnaire after the instructional set trials and retention trials. The following discussion uses the questionnaire data results and the participants in the control group only.

Analysis of overall stability revealed that nine and ten year olds who used an external cue, demonstrated less variance and better overall stability than all age group participants who used no cue in retention trial one. Nine and ten year olds who used an external focus cue were better than all age group participants who used an internal focus cue or who used no cue for retention trial two. Nine and ten year olds who used an external focus cue were better than nine and ten year olds who used no cue and 11-12 year olds who used an internal focus cue in retention trial three. There were no significant main or interaction effects for instructional set trials.

The inclusion of two control groups and the addition of the questionnaire indirectly contribute to the recent studies showing the benefits of adopting an external focus of attention. These questionnaire results begin to address what the learner is actually “thinking about” when performing a motor task. Although the control groups were not provided a focus cue, the questionnaire results revealed that when participants were “thinking about” an external focus they had better overall stability than those who were “thinking about” an internal focus or nothing. Also, the participants in the control group who chose an external focus cue on their own similarly benefited in retention to those provided an external cue and used it.

Based on all of the analyses above hypothesis one and hypothesis two are accepted. Nine and ten year olds and 11-12 year olds did benefit in balance performance and learning when they adopted an external focus of attention.

The initial analyses of instructional set trials and retention trials without the use of the questionnaire results concluded a significant main effect for age. Nine and ten year olds were better in overall stability, a/p stability, mean deflection, m/l stability and a/p deflection than 11-12 year olds for the instructional set trials. Nine and ten year olds were better in overall stability and a/p stability than 11-12 year olds for the retention trials. One possible explanation for this age main effect is the correlation between weight and overall stability and height and overall stability, r= .59, p=.001 and r= .40, p=.001, respectively. The nine and ten year olds were shorter and lighter creating less variation and better overall stability than the 11-12 year olds, see Table 3A for means and standard deviations.

Riach and Hayes (1990) sought to determine the age in which children were able to anticipate as well as compensate for postural disturbances caused by their own voluntary movements. They also attempted to document when children begin to develop anticipatory patterns of adjustments in center of pressure (COP). Riach and Hayes (1990) were unable to determine the earliest age in which postural adjustments appear since most of the participants tested were capable of generating some preparatory postural adjustments. The differences in height and weight between the two age groups in the present study might help to suggest why the nine and ten year olds were able to compensate for postural disturbances resulting in less variance in platform displacement and better overall stability than 11-12 year olds to enhance their balance performance and learning.

Shumway-Cook and Woollacott, (1985) examined the developmental changes in the patterns of variability in postural stability in children under ten years old. In particular, they sought to determine any age-related changes in which young children are dependent upon visual versus mechanical proprioceptive inputs in controlling postural stability, as well as their capacity to resolve inter-sensory conflicts. The results of this study suggested that when the central nervous system uses visual-vestibular postural inputs to make fine adjustments in ankle and foot proprioception the emergence of mature postural control may begin by the age of seven to ten years old (Shumway-Cook & Woollacott, 1985). Given the age main effect in addition to the correlation between height, weight and overall stability, the nine and ten year olds may have used their visual-vestibular postural inputs to make fine adjustments in ankle and foot proprioception better than the 11-12 year olds.

Further analysis of anterior and posterior deflection during the initial instructional set trials also revealed a three-way interaction between trials, focus group and age category. Again, this analysis does not include the questionnaire data. The nine and ten year olds who used an external focus of attention demonstrated less variance and were more centered in the sagittal plane than the 11-12 year olds who used an internal focus of attention for instructional set trials four, five and six. In addition, the nine and ten year olds who used an internal focus of attention were better than 11-12 year olds who used an internal focus of attention for instructional set trials four, five and six.

The initial retention trials without using the questionnaire data also revealed a two-way interaction for focus group and age category for medial and lateral stability. The nine and ten year olds who used an external focus of attention demonstrated less variance in platform displacement in the frontal plane than the 11-12 year olds who used an external focus of attention and the 11-12 year olds in the control group.

A possible explanation for the above interactions is that when given the instructional focus cue, the nine and ten year olds used the focus cue provided more than 11-12 year olds resulting in better a/p deflection and m/l stability. This explanation begins to address the possible need for more repetitions of the focus cue given.

The instructions given to a learner who is in the process of acquiring a new skill are crucial. Instructions occur before and during practice and include information on how to perform the skill. Instructions can enhance the learning of more complex skills, such as sports skills, and it is important to direct a learner's attention to the most relevant aspects of the task that may not have been shown or attended to in a demonstration (Wulf et. al.,1998).

In physical education verbal cues are used to emphasize the important attributes needed to execute the motor skill effectively. Verbal cues are used in effector processing to guide the learner in the development of correct movement patterns by readying the involved muscle groups or effectors for the initiation of the movement. Verbal cues can also facilitate the chunking of information to perform a sequence of a skill (Wrisberg, 1993). The Al-Abood et. al. (2002) analyses of visual search strategies as it relates to verbal instructions gives support that the influences of relevant information (i.e., adopting an external focus) enhances the performance and acquisition of motor skills.

Currently verbal cues in physical education utilize both an external and internal focus when teaching motor skills. Examples for striking with both sides of a paddle are: place your paddle flat on the floor, pick up the paddle and see if you can keep it as flat as it was on the floor (external focus). Or pretend you have a cast on your wrist, “stiff wrist” (internal focus) as you strike the ball on both sides of the paddle while standing in one place (Graham et. al., 2004). Participants in the present study were provided with instructions that emphasized either an external or internal focus of attention when performing a balance task. The external focus instructional cue stand as still as possible while “keeping the platform still” may have allowed participants to use an automatic control process to enhance balance performance and learning. Using verbal cues in physical education such as when teaching a balance task that emphasizes external verbal cues will allow young learners to use an automatic control process that will enhance the movement pattern. This study provides encouraging data to support the benefits of using an external focus in verbal cues for motor learning in physical education.

Conclusions

The findings from the present study have led to the following conclusions:

1. There are benefits of adopting an external focus of attention for children nine through 12 years old.
2. Participants who were “given an external focus cue and said they used it” were better in balance performance and learning than

those participants who were “given an internal cue and said they used it”.

3. All participants who said they used an external focus cue were better in balance performance and learning than participants who used an internal focus cue.
4. Participants in the control group learned to balance better when “thinking about” an external focus of attention.
5. The differences between height and weight between nine and ten year olds and 11-12 year olds may have contributed to superior balance in the nine and ten year olds.

Implications For Future Research

In order to enhance the understanding of the benefits of adopting an external focus of attention for children and when teaching motor skills in physical education, the present study makes the following suggestions for future investigations in this area:

1. Use younger subjects to determine if they can benefit from adopting an external focus of attention (i.e. six through nine year olds).
2. Use more practice trials for performance and learning. Since there was minimal improvement in the instructional set trials without the questionnaire data, the effects of the instructional focus cues may be better realized with a task that incorporates more practice.
3. Examine the effectiveness of external instructional verbal cues in physical education classes by using whole groups of intact classes compared to similar groups with only internal instructional verbal cues.
4. Utilize an external focus of attention with many other physical education skills for young children such as tumbling, throwing, catching, and striking with implements.

5. Utilize an external focus of attention for stages three and four (offense or defense strategies) for game strategies in physical education classes.

APPENDIX A

INFORMED CONSENT FORM

Dear Parent or Guardian;

My name is Jenifer Thorn and I am a doctoral student under the direction of Dr. Charles Imwold in the Department of Sport Management, Recreation Management, and Physical Education at Florida State University. I am conducting a research study to determine the benefits of focus of attention and balance learning.

Your child's participation will involve balancing on a "Balance Master" a high-density, molded plastic board with a nonskid surface that measures 29"L x 9"W x 6.5"H. A balance board such as the "Balance Master" is a teaching method used in physical education to assess balance. Your child will stand on the "Balance Master" for two trials. I will be directly behind your child for assistance to prevent a fall.

Next your child will be asked to balance on a machine called a "Biodex Balance System". The Biodex is a balance system that is the height of a doctor's scale with a large moveable platform at the base. Your child will be asked to balance on this platform six times for a duration of 20 seconds each. While balancing your child will be provided with a specific focus of attention strategy. Following the six trials, your child will be given a questionnaire consisting of two questions.

A retention test will be given to your child one week later. The retention test will consist of three trials using the Biodex System followed by the same questionnaire.

The benefit of your child's participation will be to better understand how focus of attention enhances balance performance and learning.

The results of this study may be used for publication or presentations at professional conferences. Your child's response will be confidential to the full extent of the law, and no names will be documented.

If you have any questions concerning this research study or your child's participation in this study, please call Jenifer Thorn (850) 668-9134 or Charles Imwold at (850) 644-4813.

Sincerely,
Jenifer Thorn

I give permission for my child_________________________________ to participate in the above study. I understand that this consent may be withdrawn at any time without penalty and my child's grades in physical education will not be affected.

Parent or Guardian Name: ____

Parent or Guardian Signature: ______________________________Date: __________________

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

APPENDIX B

Child Assent Form

I have been told that my parent(s) have given permission for me to participate, if I want to, in a study about focus of attention and balance performance and learning. I will be asked to balance on a “Balance Master” similar to the balance boards used in my physical education classes. Next, I will be asked to balance on a machine that has a moveable platform similar to a doctor’s scale. I will be asked to balance on this machine six times during one of my physical education classes. Afterwards, I will be asked two questions about balance. One week later, I will balance three more times on the same balance machine, and answer the same two questions about balance.

My participation in this study is voluntary and I have been told that I may stop my participation at any time. If I choose not to participate, it will not affect my grade in physical education, in any way.

Name: ___________________________ Date: ____/____/____

APPENDIX C

Balance Questionnaire

1. What helped you balance on the Biodex?
2. What were you thinking about while you were balancing on the Biodex?

APPENDIX D

Florida State
UNIVERSITY

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2763
(850) 644-8633 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 9/22/2005

To:
Jenifer4 Thorn
2074 West Forest Drive
Tallhassee, FL 32303

Dept.: **SPORT MANAGEMENT**

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

Re: **Use of Human Subjects in Research**
Using Attentional Strategies for Balance Performance and Learning in Children Nine Through Twelve Years Old

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on **9/14/2005**. Your project was approved by the Committee.

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

If the project has not been completed by **9/13/2006** you must request renewed approval for continuation of the project.

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

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

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

cc: Dr. Charles Imwold
HSC No. 2005.681

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BIOGRAPHICAL SKETCH

Jenifer Ellen Thorn

2074 W. Forest Drive
Tallahassee, Florida 32303
Phone (850) 519-0868
EMAIL: jet02e@fsu.edu

Professional Objective

To obtain a doctoral degree in pedagogy at Florida State University that will enable me to teach and apply research in Physical Education at the university level.

Education

2006 ABD, Ph.D. in Physical Education Pedagogy (Cognate in Statistics), Florida State Florida State University, Tallahassee, FL
1992 M.A. in Exercise Science, Western Michigan University, Kalamazoo, MI
1987 B.S. in Physical Education and Health, Baylor University, Waco, TX

Certification

1995-present Michigan Teaching Certificate, Teaching Areas: Physical Education, Health, and Science.

Professional Experience

2004-2005 **Physical Education Coordinator and Driver Education Coordinator**, Florida Department of Education, Tallahassee, FL.

* Recommend the research design for the legislatively required Florida Department of Education study on the status of physical education in the state of Florida.
* Develop recommendations for the most efficient ways to increase physical education and assess the fiscal impact of each recommended change.
* Select or develop a physical fitness assessment for all districts
* Develop support materials for districts to enable the implementation of fitness assessment programs.
* Review the Sunshine State Standards for physical education and make recommended changes.
* Develop Grade Level Expectations for grade K-8 in physical education.
* Develop specifications for physical education instructional materials in the textbook adoption process.
* Review and recommend new college courses for dual enrollment in physical education.

* Inform districts on new legislation and statutes pertaining to physical education and driver education.

2002-2006 **Doctoral Student in Physical Education- Pedagogy**
Department of Sport Management, Recreation Management and Physical Education, Florida State University, Tallahassee, FL.
Graduate Teaching Assistant

* Science of Nutrition- Department of Nutrition, Food and Exercise Sciences-Fall 2005
* Theory and Practice of Baseball Coaching- Fall 2005
* Anatomy and Physiology- Summer 2004
* Lifetime Activities Program: Volleyball- Spring 2004
* Human Movement Studies- Summer 2003/Fall 2003
* Motor Learning/Control- Department of Nutrition, Food and Exercise Sciences- Fall 2003
* Theory and Practice of Softball Coaching-Spring 2003/2004
* Lifetime Activities Program: Aerobic Conditioning- Fall 2002
* Evaluate Physical Education Teacher Education undergraduates in elementary and middle school practicum classes-Fall 2002/Spring 2003
* Provided Service-Learning training to Physical Education Teacher Education undergraduates- Fall 2002/Spring 2003
* Focus Group for Graduate Enrollment Enhancement, Member- Spring 2004
* Physical Education Faculty Search Committee, Member- Fall 2003
* Team-building Leader for NCAA-YES Soccer Clinic- Fall 2002

1994-2002 **Science Teacher and Coach,** Hamilton Junior-Senior High School, Hamilton, MI.

* Integrated Science and Health classes- grade 8-12.
* Assist in the development of Integrated and Life Science Curriculum
* Create school goals in Cultural Diversity for NCA Accreditation
* Athletic Council Member, 1995-2002
*Varsity Softball Coach, 1999-2002
*Varsity Tennis Coach, 1996-1999
*Junior Varsity Volleyball Coach, 1996
*Middle School Volleyball Coach, 1994-1995
*Assistant Track Coach, 1995

1988-1994 **Science Teacher and Coach**, Palmetto Middle School, Miami, FL.

* Physical Science and Health Classes- grades 8-9
* 8th grade Team Leader
* Assist in the development of Critical Thinking Workshops
* Assist in the development of a middle school AIDS Curriculum
* Assist in the development of an Integrated Curriculum
* Volleyball Coach, 1988-1991
* Softball Coach, 1988-1991

1995 **Assistant Head Volleyball Coach**, Hope College, Holland, MI.
* Second place finish in the MIAA

1991-1992 **Graduate Assistant**, Western Michigan University, Kalamazoo, MI.
* Physical Education Activity classes- Volleyball, Tennis, and Racquetball

1988	**Elementary Teacher**, St. Matthew's Lutheran Day School, Miami, FL. * First and Second grade teacher
1987	**Student Teacher**, Midway High School, Hewitt, Tx. * Physical Education and Health classes

Awards

2002	* **Area Softball Coach of the Year**, Zeeland Record, Zeeland, MI.
1994	* **Middle School Health/Science Teacher of the Year**, Palmetto Middle School, Dade County Public Schools, Miami, FL.
1988	* **New Teacher of the Year**, Palmetto Middle School, Dade County Public Schools, Miami, FL.

Publications

Hannon, J., Ratliffe, T., Thorn, J., & Holt, B. (2004). Female Adolescents Views of Coed and Single-Gender Physical Education. *Research Quarterly for Exercise and Sport,* 75(1), A-100.

Presentations

Hannon, J., Ratliffe, T., and Thorn, J. Adolescent Male and Female Activity Levels During High School Physical Education: Coed and Single Gender Settings. Presented to the American Alliance for Health, Physical Education, Recreation and Dance April, 2004.

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Toole, T., Thorn, J.E., Panton, L., & White, J. The Effects of a 3-Month Walking Program on Mobility and Balance in Obese Lower Socioeconomic Status Middle-aged Women. Paper presented to the American College of Sports Medicine June, 2004, Indianapolis, IN.

Manuscripts Submitted

McNiven, N., Wulf, G., Toole, T., & Thorn, J.E., Attentional Dynamics During Platform Posturography: Effects on Older Adults and Falls Risk. Manuscript submitted 2005.

Toole, T., Thorn, J.E., Panton, L., Kingsley, D., & Haymes, E.M. The Effects of a 12-Month Pedometer Walking Program on Mobility and Balance in Obese Lower Socioeconomic Status Middle-aged Women. Manuscript submitted 2005.

Grants Received

Stierwalt, J., Toole, T., LaPointe, L., Maitland, G., & Thorn, J. Effects of Linguistic Load on Posture, Balance, and Gait in Individuals with Neurological Impairment. $25,000 grant from Florida State University, 2004-2005.

Manuscript in Progress

Thorn, J., The Effects of an Internal and External Focus of Attention on a Dynamic Balance Task

Dissertation in Progress

Using Attentional Strategies for Balance Performance and Learning in 9-12 year olds. Prospectus Defense, October 2005. Data Collection completed, December 2005. Final Defense expected, March 14, 2006. Graduation expected, April 29, 2006.

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