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Effect Of Handedness On Gross Motor Skill Acquisition Among College Undergraduates

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in Kinesiology

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ABSRACT

There is little applicable research investigating educational adaptation for handedness and even less research dealing with physical skill development. Given that PE teachers and students frequently rely on demonstrations to enhance learning, this study sought to determine if the congruence between teacher and student handedness is important? It was hypothesized that performance and form scores of left-handers that see a right-handed demonstration would be significantly higher than those of right-handers that see a left-handed demonstration.

A lacrosse shot was demonstrated to a group of 69 college-aged participants that were equally split in numbers between male and female and left and right-handers. Half of each group saw a left-handed demonstration while the other half saw a right-handed demonstration. Participants were assessed on target accuracy and four components of shot form. A planned comparison ANOVA was used to test the hypotheses.

Results showed that left-handers performed significantly better than right-handers on target accuracy (F (3, 68) = 4.38, p = .007), shot form (F (3, 68) = 2.87, p = .043) and body positioning (F (3, 68) = 4.51, p = .006).

Left- handed college students appear to be able to glean important information from an opposite-handed demonstration but the right-handers do not seem as adept. Because this study used college students, future research should examine younger children, as they have had less experience to adjust (much like right-handers seeing left handed demonstration)

This Dissertation is approved for
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DEDICATION

This dissertation is dedicated to my wife Nichelle whose initial insistence to pursue my doctorate and then subsequent support during the entire process were the two most important factors that allowed for its inevitable completion.

I would also like to thank my parents, Alton and Juanita Parish, whose active, steadfast support for me and higher education in general was central to my current level of success.

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CHAPTER 1

INTRODUCTION

Left-handed people have long seemed an outlying oddity in society. Although the left-handed population percentage has stayed fairly consistent, little empirical research has been done regarding how society has adapted common activities to meet their needs. This situation is especially true educationally. Educational methodology in regards to handedness has received only anecdotal study. Even fewer empirical studies are available regarding gross motor skills. The few studies that have been conducted regarding adaptive teaching methodology for handedness have focused on teaching handwriting to left-handed people (Kelly, 1997; Hatta & Kawakami,1995; Provins & Glencross,1968; Provins & Magliaro,1993; Schott & Schott, 2004).

In addition to handwriting, there have been a few other examinations of handedness and adaptive teaching methods. For example, Lareng and Park (1999) examined what effect handedness had on learning to play the piano. Another study looked at what effect handedness had on the use of a computer mouse (Delisle, Imbeau, Santos, Plamondon, and Montpetit, 2004).

Although there has been little applicable research into educational adaptation for handedness, there have been several studies discussing the issues that educating a left-handed student creates. Similar studies by Fowler (1996), Wenze and Wenze (2004), and Winslow (2001) examined the effect that focus levels had on creating teaching styles. Most particularly, these studies dealt with those styles that can be adapted for handedness. Additional studies by Montgomery (1996) and Walker (1998) also illuminate the detrimental effects that lack of focus on inclusion of adaptive handedness teaching methodology can have on left-handed people. A final study found that left-handed children scored significantly worse in skill acquisition on most gross motor skills (Left-HandedChildren.org, 2006).

Statistically, left-handedness varies over generational groupings (Pachioli, 2001). In people under the age of 20, 13% are classified as left-handed. Between ages 21 and 50, the number drops to 5%. From 51 to 80, the number falls to less than 1%. The reasons for the disparagement vary. In part, the statistical anomaly is predicated on the fact that for most of the early part of the century, left-handedness was dissuaded from use by parents and society as a whole. Most people born in the early 1900's had little choice but to use their right hand despite their natural inclinations otherwise. Others simply got tired of working against an established right handed system. Today, the numbers of left-handers are up significantly as much of the abusive discouragement of left-handedness has subsided (Pachioli, 2001).

A second possible reason for the lower numbers of left-handed individuals among older populations is more directly related to the concerns discussed in this paper. Research shows that average life-expectancy is nine years less for a left-handed person from that of their right handed counterparts. A 1992 report on this discrepancy, or difference in mortality rates, attributed this in large part to deaths by accidents. The report reasoned that the higher level of accidental deaths was largely due to the fact that society is designed for right-handers; this situation makes left-handers seem clumsy (Coren, 1992).

Historical Background

Society has long had an innate prejudice toward left-handed individuals. This prejudice has led to many cultures conjuring up extreme ways to force individuals to conform to using their right hand. Cultures in Indonesia, the North American Indians, and the Muslems would bind children's left hands to force them to use their right. Although binding a left arm might seem barbaric in nature, it pales in comparison to other much more incredulous methods of left-handed dissuasion. The Kaffirs of South Africa would bury left-handed children's hands in scalding sand to make those left hands unusable. Pre-World War II, the Japanese would beat any child displaying a preference to the left hand. Social, economic and political rights and privileges were restricted for left-handed men, and left-handed women were not considered appropriate for marriage (Costas 1996).

This general disdain for left-handedness is even supported by generally recognized definitions of the word. Many languages spoken before 3000 B.C. did not even have a word for left. Later, when a word defining left was created, it was less than flattering. The word for left in Latin is sinister (from which our modern term sinister is derived) while its reciprocal counterpart for right is dextor (from which dexterous is derived). Skaios is the word for left-handed in Greek and means ill-omened or awkward. Hindi refers to left-handed as Ulta HaanthEven, or more simply put, wrong the hand. The French term for left-handed is gauche which translates to clumsy (Wright, 2007). Even the modern day American Heritage Dictionary's (2007) third definition for left-handed is defined as awkward or maladroit.

Despite the long history of discord shown to left-handedness, there was a time when being left-handed did not make one an outcast. Studies of early hand tracings from cave walls seem to support the belief that up to 80% of all Cro-Magnon people were left-handed. Researchers believe that the disparity for right- handedness did not come to prominence until the Bronze Age at around 3000 B.C. During the Bronze Age, more complex tools and weapons came into being. These tools worked best when used by one hand. Creation of these tools was time consuming and forced single sets to be made for only one handedness. Although the difference in numbers of right and left-handed individuals was more evenly spaced than it is now, it is believed that this was the advent of the rise to dominance of right-handedness (Manning, 2004).

Physiological Background

Genetic linkage or heredity has long been considered the most widely recognized link to left-handedness. Countless studies have found similar results validating to some degree the link between heredity and left-handedness. For example, if both parents are left-handed, a child is twice as likely to be left-handed (Chamberlain, 2010). If neither parent is left-handed, it is rare that any of their children will be left-handed (Rife, 1951). Although most research does not give statistical absolutes, their findings do seem to indicate that there is some basis for acknowledging the fact that gene linkage is a viable explanation for handedness.

Recently, there has been some scientific research that seems to support a correlative link between gene linkage and left-handedness. In 2007, an apparent gene linked to left-handedness was found. Known as LRRTM1, the gene is usually inherited from a person's father. Although the gene's presence is not absolutely necessary for left-handedness, it can be a big indicator (Ravilious, 2007). Klar, an early researcher of the notion of the handed gene, found early statistical evidence verifying the impact of such a gene. Although his early suppositions of the left-handed gene came before the presence of LRRTM1 had been substantiated, he hypothesized that those individuals having the handed gene will almost always be right handed and that those lacking the gene will have a 50/50 chance of being left-handed (Rosenbaum, 2000).

The fact that left-handedness is so infrequent world-wide in comparison to right-handedness suggests that there might be a need to consider a multiple convergence of factors in order to explain such a rare phenomenon. Continuation of current research trends might soon give better validation for what causes left-handedness.

Personal Background

Research regarding handedness became a topic of interest to the researcher after the birth of his first daughter. Although she rotated back and forth between picking a dominant hand for the first two or three years of her life, by age four it became evident that she was prone toward the left side. Until this point the researcher for this study had never found any real world significance relevant to handedness. There were no left-handed individuals from his or his wife's families. He had grown up around friends that were left-handed but had really never paid much attention to the fact that many of their movements were opposite to my own. Other than having a difficult time returning an occasional left-handed serve when playing tennis, this researcher had noticed no particular oddities in anyone being left-handed. He also did not see handedness as any measured impedance in the day-to-day activities in peoples' lives.

It was not until he was conducting a series of adaptive tests with his daughter that he first realized the difficulty that left-handedness can cause. During the course of these tests it became evident that portions of them were painfully biased toward right-handed people. As his daughter struggled with some of these components, he wondered if she was being given accurate assessment. The testing disparagement led me to an even larger query. As a long-time, right-handed physical education teacher, this studies researcher realized that he had never given a skill demonstration with the left-hand. His class demonstrations had always been concluded with a statement of "Left-handers do the opposite of what I just did". He further realized that he had given no discernible skill instruction to any individual in the class that was left-handed. Follow up discussions with fellow physical educators found that they, too, were remiss in skill demonstrations for left-handed students. This study's researcher now wondered if his demonstration bias had negatively affected the left-handed students in his classes. Furthermore, he wondered if this bias spoke to a larger issue of whether left-handed individuals were in some capacity being neglected by the educational system.

Purpose of the Study

The purpose of this study was to determine if the categorical differences that are inherent between right and left-handed individuals affect the way in which they are able to learn. Furthermore, this studies far reaching goal is to ascertain whether left-and right-handers can learn a skill effectively when seeing a demonstration from either the right or left-handed instructor.

Research Hypotheses

1. It is anticipated that the target scores achieved by left-handers that see a right-handed demonstration will be significantly higher than the target scores achieved by right-handers that see a left-handed demonstration.

2. It is anticipated that the rubric scores on shot form achieved by left-handers that see a right-handed demonstration will be significantly higher than the rubric scores on shot form achieved by right-handers that see a left-handed demonstration.

Definitions

<u>Correlation</u> – Indicator of the strength and direction of a linear relationship between two random variables.

<u>Cues</u> - Cues are defined as a set of signals, such as words or actions, used to prompt another event in a performance.

<u>Demonstrations</u> - Demonstration is a presentation to others of the way in which something works or is done.

Feedback - Feedback is defined as the return of information about the result of a process or activity; an evaluative response.

Gross motor skills - Gross motor skills are the abilities required in order to control the large muscles of the body for walking, running, sitting, crawling, and other activities.

Handedness - Handedness refers to the preferential use of one hand for most fine manual tasks.

Interaction (Statistical) – Statistical interaction is the combined effect of two or more independent variables acting simultaneously on a dependent variable.

Lacrosse - Lacrosse is a goal game in which players use a long-handled stick that has a triangular head with a mesh pouch for catching, carrying, and throwing the ball.

Main Effect - The effect of the change in level of one factor in a factorial experiment measured independently of other variables.

MANOVA - Multivariate analysis of variance is a statistical method used to cover cases where there is more than one dependent variable and where the dependent variables cannot simply be combined.

Modeling - Modeling is learned behavior through observation that can later be coded to serve as a guide for action.

Assumptions

There were several assumptions that were necessary for this study to have an adequate level of validity. First, it was assumed that all individuals used as participants in this study were being honest in regards to their true handedness. This study could have only been relevant if individuals were tested both in their alternate handedness. Secondly, it is assumed that all individuals used as participants in this study were giving maximum effort to properly perform the skill that was being used. Effort is virtually impossible to assess but was instrumentally necessary in ascertaining significance. The final assumption focused on the activity used in the study. It was assumed that lacrosse is good activity to use in assessing gross motor skill level. This assumption included not only whether lacrosse was a good sport to use as an overall gross motor skill assessor, but it further assumed that lacrosse was an activity in which handedness played a role in skill level.

Limitations

There were a couple of possible limitations that could have affected the results of this study. The first concerned any differentiation that might have occurred from using males and females in the study. It was unknown if there would be outlying differences in results based upon gender. Secondly, it was not known what the athletic level was of the various participants. Some individuals were much more apt at learning a new skill than others were. This could have been a negative affecter on the overall results. These limitations were minimized by using the same number of males and females for the participant group and by random assignment to groups.

Significance of Study

This study attempts to make a difference in the lives of left-handed individuals. Should performance differences between right and left-handers be found, the implications to educational methodology could be significant as there might be a need for alterations to current teaching methodology for left-handed individuals. These alterations could range from increased funding for things such as equipment to training programs to better assist with left-handed accommodation. Educational equity is something that must and should be inclusive to all students regardless of mental or physical level. Left-handed individuals should receive no less consideration.

CHAPTER 2

REVIEW OF LITERATURE

This literature review examined if there is need for alternative teaching methods among left-handed students for learning gross motor skills. It examined the most prominent teaching methodology for gross motor skills which utilizes modeling. In addition, the literature review also explored possible educational grouping of left-handed individuals and subsequent funding as well as possible solutions for their future educational success.

The literature review first looked at motor learning, creating a working definition. After creating a definition, it then defines and analyses modeling and how it relates back to motor learning. After examining motor learning, the review then focused on equal or equitable opportunities for handedness. Particular focus in this section was paid to general educational issues and specific physical education issues. Next, the review shifts focus to the prospect of re-classifying handedness into its own adapted group. Educational grouping is given primary focus in this subheading. Finally, the review examines various components of teaching handedness. Beginning with left-handed motor skill performance this section then shifts focus to handwriting and similarly related activities. The section concludes with possible teaching solutions in response to handedness by examining mirroring and other related approaches.

Motor Learning

For the better part of modern education's most primitive origins, motor learning has been a central theme and found a central place within its borders. Although there is little debate that motor learning is the cornerstone to all activity based movements that are performed on a daily basis, there has been some argument as to how to define motor learning and what enables substantive motor learning to occur (Thomson, Jaakkola, & Liukkonen, 2006).

A modernized definition of motor learning, created by Thomson, Jaakkola, & Liukkonen, (2006), takes a broader approach in its defining parameters. They define motor learning as the learning of new acts which consists of both motor and sensory components. This definition takes a more holistic approach which expands what they consider to be included into the constructs of motor learning.

Adams' (1971) definition defined motor learning as the acquisition of skills or skilled movements as a result of practice. He theorized that several processes required congruency for motor learning to occur. Known as the closed loop theory of motor learning, Adams focused his research and theory parameters on motor memory initiating a movement. The more properly learned the movement and the more it is practiced, the better it will be stored in memory to be drawn upon for future use. Once the skill is learned, Adams believed that the central nervous system created internal memory error regulators known as perceptual tracers. These tracers serve as templates for individuals to self-correct when performing a motor skill. Self-feedback compares current performance to stored ones that are kept as memories and makes alterations and refinements to correct errors. Specific demonstrations and cue usage are essential in order for these corrections to be made, as specificity to learning perfect form is a must for the autonomic performance.

In somewhat of a contrast to Adams' closed loop theory, Schmidt (1988) defined motor learning as a set of internal processes associated with practice or experience leading to relatively permanent changes in the capability for responding. In deference to Adams, Schmidt believed that motor skills were more appropriately learned from a variety of different circumstances. Schmidt's concept, known as schema theory, focused on individuals learning more efficiently from generalized motor programs instead of the specific error free programs described in Adams theory. He believed that parameters involving different variables such as distance, direction, or dimension were more important to learning a motor skill than specific form. By allowing the mind and body to explore different durations and forces, exemplary movement outcome was learned and encoded in the central nervous system to be drawn upon for future use.

Supporting his earlier premise, Schmidt and Wrisberg (2008) expanded on why they believed schema theory was more appropriate to real world application than the closed loop concept. They theorized that that activities like swinging a weighted bat before hitting or running with leg weights leading up to a race did not improve performance because those types of preparation techniques were not congruent with actual real world application. According to Schmidt (1988), trial and error are vital to learning a gross motor skill and inappropriate practice techniques do not aid in truly retentive gross motor skill acquisition.

Despite his oppositions to some components of Adams' theory, Schmidt did agree that having a feedback based teaching methodology was vital for motor learning. In his book co-written with Lee (2005), he discusses how modeling is important in gross motor learning provided it is not so rigidly constructed that it inhibits adaptation. One adaptation he mentioned was particularly applicable to the present study. Known as constraint-induced physical therapy, this adaptation involves restraining a good limb in order to make the bad limb develop. Schmidt believes that although constraint-induced physical therapy is primarily used with neuromuscular issues, it could be applied appropriately to gross motor learning too. By forcing the body to adapt, learning is promoted and better embedded within our central nervous system for future use (Schmidt, 1988).

Adaptable learning is of particular interest because learning a particular motor skill is something that individuals can adapt to over a period of time in similar fashion to those adaptations outlined in schema theory. More specifically, are the focused variables of adaptability prescribed by Schmidt synchronous to those forced into use by left-handed people? It seems that Schmidt's variables of dimension and direction might be similar to the adaptations that left-handed people utilize when learning a gross motor skill from a right-handed instructor.

Modeling

When discussing teaching methodology, most specifically as it applies to the acquisition of gross motor skills, modeling has become the central teaching template for instruction. The most prominent definition of modeling, as it applies to education, was written by Bandura (1969). He defined modeling as learned behavior through observation and later expanded the definition to include the premise that this learned behavior can later be coded to serve as a guide for action (Bandura, 1976).

Bandura (1977) believed that in order for proper modeling to take place as a teaching methodology, it must adhere to four conditions. First, there must be a necessary level of attention paid by the person being taught the behavior. If there are any distractions or learning obstacles, attention is lost and modeling is less effective in its desired outcome. Secondly, Bandura believed there must be retention on the part of the learner. This might seem to state the obvious; but in order for learning to be substantially retained, there needed to be some semblance of symbolic coding and rehearsal in order for mental images to be created and motor learning to occur. This was further explained in his third condition which discussed how a physical reproduction of an observed skill and self-reflection of that performance by the learner led to the creation of a mental image and continuity for future attempts of that skill. This mental imaging transitioned into the final condition Bandura discussed which he termed as motivation. Bandura believed that in order for a learner to be motivated to continue to practice and learn a motor skill, the instructor must include imagined incentives and reinforcing or recall methods to assist in the learning. The imagined incentives refer to the benefits that learning the motor skill could ultimately produce for the learner. These benefits might be as little as proficiency in a gross motor skill, like throwing, to improvement in a sport such as football.

Bandura's social learning theory and its subsequent conditions for successful implementation seem to somewhat support the assumptions that modeling is the necessary component to successfully learning a gross motor skill. This modeling must include both specific demonstrations by the instructor and repeatable cues that can be reproduced by the learner.

Using Bandura's social learning theory as a guide, many researchers have taken his concept and looked at how it could be used as an educational model. These researchers looked for linkage in the possibility that institutional education could be taught using Bandura's premise. Simply put, could standard educational skills be taught with the emphasis being placed, as Bandura believed, on the necessity of embedding these skills into easily repeatable cues for repeated practice?

One of these researchers, Hartjen (1974), took a literal analysis of Bandura's theories as they apply to education and learning. Hartjen looked specifically at how effective standard teacher intern practices served as a training tool. He believed that intern teachers were not trained to differentiate between good and poor teaching strategies and practices. Hartjen believed that because of these poor training methods, which were imparted to the interns, mentor teachers were not able to give accurate assessment to the interns. Hartjen agreed with Bandura that multiple observations followed repeated practice were necessary in order for learning to be successful. Viewing multiple observations, reinforcing appropriate cues, and having multiple practice sessions were significantly impactful training methods. This practice of follow up training sessions helped the interns recognize proper teaching techniques. Once they are able to recognize proper techniques, they are then able to create their own cues to enable them to remember and replicate these techniques.

Another educationally based researcher, Artino (2007) also in agreement with Bandura, asserted that repeated practice must occur in order for new information to be placed into retrievable memory. Using Bandura's original theory and the human cognitive theory as the basis for his assertions, Artino stated that new information can only be remembered for 15 to 30 seconds unless there is both relevant instruction and relevant demonstration by the instructor, followed by repeated practice that incorporates an easily accessed memory tool such as a cue. He stated that this is necessary for the human cognitive architecture to really be properly accessed and for substantive learning to really take place.

Glaser (Collins, Brown, & Newman, 1989) followed suit in support of modeling as effectively working as a skill teaching technique. However, Glaser promoted a less esoteric statement in regards to motor skill learning. Contrary to the general popular belief at the time of his writings, Glaser maintained that modeling techniques that utilized both demonstrations and cues could be applied to most skill acquisition. He believed that it was incumbent on educators, in all educational disciplines, to apply modeling to their teaching. If proper demonstration and cue utilization could be applied by the educator, and if repeated practice attempts could be waged by the student, most individuals could effectively learn most skills.

Collins, Brown, and Newman (1989) also wrote in support of the importance of modeling technique as a method for teaching motor skills. Following opinion put forth by Glaser (1989), Collins, et al. (1989) maintained that modeling works significantly better than a didactic approach when teaching motor skills. Using old internship practices as the basis for their supportive opinion of Glaser, the authors asserted that motor skill practices, both basic and advanced, are received, processed and remembered far better through demonstrations and repeated attempts than simple instruction. They especially focused on the relative importance that proper demonstration has in the learning of a target skill. If the demonstration is sound and there are enough practice attempts made, the authors believed that motor skill learning can be affectively absorbed by just about anyone.

More substantive research by Bailey (2009) specifically examined the relevance that modeling, as a teaching methodology, can have on physical education. Similar to the aforementioned researchers, Bailey asserted that visual demonstrations were not only important but imminently necessary for the acquisition of gross motor skills. Bailey also maintained that it is incumbent, on the part of the educator, to perform a demonstration that is easy to follow, age appropriate, and physically applicable to the individuals who are being taught. More specifically, he contended that demonstrations should reflect, as clearly as possible, the context in which observers will be performing the skill. Bailey believed that demonstrations that are not easily replicable on the part of those being taught are ineffective. If the demonstrations are not appropriately tailored to the audience, motor learning will not occur as effectively.

Equal Opportunity for Handedness

Educational Issues

As previously mentioned, there has been a movement toward a more universal acceptance of left-handedness. Costas (1996) discussed this shift from how left-handed students had for years been made to feel abnormal in schools to the recent movement toward acceptance. Because of this shift, there has been a new light put on a variety of inequities regarding left-handers treatment in general society. One of the more prominent inequities that Costas discussed is in educational opportunity. She found that the preponderance of recent research has not kept up with or been sensitive to this large sect of society.

Winslow (2001) noted on the educational issues mentioned by Costas. She particularly focused on teachers' teaching practices toward left-handers. Winslow asserted that if teachers do not pay some attention to how the left-handed students (often comprising 10% of their class) are absorbing what they are being taught, serious detrimental effects could befall these students for years to come.

A subsequent study by Wenze and Wenze (2004) found startling results that seemed to confirm much of what Winslow had discussed in her earlier article. They wanted to examine how schools were creating adaptations for left-handers to aid in the learning. They also wanted look at what role teachers played, outside the parameters of providing materials, in teaching skills to left-handed students. Their results were revealing. Almost universally in all age groups, students credited their parents, not their teachers, for both supporting their left-handedness and teaching them basic skills. These skills included basic skills like writing and cutting with scissors, to more advanced motor skills like dribbling a basketball.

These results were not based on one-sided input. By the teachers' own admissions, they (the teachers themselves) did not do much for left-handed learning other than providing materials such as rulers, and providing furniture such as left-handed desks. More specifically, they did very few, if any, left-handed demonstrations. They also admitted to inadvertently embarrassing some of their left-handed students by specifically pointing them out. These results prompted the researchers to conclude that although the issue of handedness may be unimportant to the majority of the population, the results from this study warrant a need for continuing research (Wenze & Wenze, 2004).

Johnston, Nicholls, Shah, and Shields (2009) took the issue of educational inequity, in regards to handedness, to an even more serious level. The researchers found that left-handed children were far more likely to suffer a variety of development issues than were their counterpart right-handers. The results were not attributed to any specific demographic indicators and seemed to stem more from a lack of societal support.

Research in educational equity for left-handers has been a subject of somewhat recent focus in Great Britain. Two studies specifically looked at attempts by the national school system in England to create teacher training programs designed to help teachers better accommodate left-handed students. Walker (1998) examined the movement by England to establish a specific in-school training program to train teachers on site to better accommodate left-handed students. Walker focused his study on Estelle Morris, England's school standards minister, who herself is left-handed. She has developed a series of special needs coordinators to help teachers not only be more sensitive to left-handers but also manage their classes to better accommodate their needs. Walker maintains that this program should be something that is looked at by other countries as a possible framework for improving educational equity to left-handers.

A second study by Montgomery (1996) investigated how parliament has taken up the cause of improving educational access for left-handed students. Montgomery believes that the national movement for educational equity for left-handers will eventually culminate in better training programs within teaching universities themselves. He pointed out that before training programs can actually have tangible positive results, there must be more of a consensus on which teaching methods are most appropriate and applicable.

Physical Education Issues

Although the issue of handedness equality in education is applicable to many subject areas, it would seem most prominently problematic to physical education. The primary reason for its seriousness in regards to physical education is that physical education classes incorporate the use of many gross motor skills. Earlier articles in this review of literature display heavy amounts of that research that show that modeling, demonstrations, and cues are needed to properly and effectively learn gross motor skills. This assumption, if completely true, would mean that left-handed educational inequity in physical education would compromise those gross motor skills from being learned.

Researchers are now picking up on this issue. Xu, Gao, Liang and Li (2007) looked at how a lack gross motor skills knowledge can actually lead to diminished mental intellect. They called the hand the "parents" of the brain. Their research found that overall intellect, memory, and general smartness of thinking could be somewhat correlated to gross motor skill acquisition associated with the hand. The authors pointed out those most left-handed individuals are left out of proper hand/skill training. This is especially true among children and teenagers. Xu et al. worry that that this inequity of training and education in sports and physical education programs could stymie this intellectual development on the part of left-handers.

Left-Handed Children.org (2006) tried to validate claims by other researchers regarding the educational inequity toward left-handers. This qualitative study took a large sample of left-handers and gauged their proficiency in a large number of gross motor skills that were most generally associated with sports or physical education. They then shared a number of the subjects' quotes regarding how they felt about their gross motor skill adeptness and their experiences in learning these skills. There was a consensus of difficulty involved in learning these skills on the part of the subjects. These difficulties spanned a broad spectrum of types of activities. From baseball to archery to canoeing, there was a universal statement by all of the respondents that a lack of proper demonstrations and accommodations were the main reasons for their failure to learn the skills.

Some of the respondents' comments included:

> "Learning to fish was crazy. All this 10 & 2 business didn't make any sense till I reversed the clock in my mind to figure out what the right-handers were talking about."
>
> "It was hard to learn baseball, golf because you have to reinterpret any instructions to the opposite hand which puts you behind."
>
> "Canoeing is hard to learn because most double paddles have the decalage for feathering the paddle so that the paddle is turned by the right wrist, but one adapts to it."
>
> "Archery is hard to learn because of a lack of left-handed bows."
>
> "In throwing events in athletics especially and in some other sports, teachers are unable to do the action as a left-hander would so you usually have to turn everything around."

> "It is difficult to find equipment, especially in school (baseball mitts, ice hockey sticks, field hockey doesn't allow left-handed play at all)."
>
> "You have to think opposite to what the teacher is saying and sometimes takes a bit longer to pick up."

The comments by the left-handers, in this study, seem to show a fairly universal belief by left-handers themselves that there is an inequity in their educational accommodations.

Re-classifying Handedness

Educational Grouping

With a greater global acceptance of their uniqueness, the number of left-handed individuals and their subsequent educational issues seem destined to continue to rise. It seems there might now be a need to possibly create a separate educational grouping for them. As with some minority or special needs groups, it might now be appropriate to re-classify left-handed students as a separate educational group in order to insure equal educational access.

Before addressing the issue above, it seems important to first define what entails a minority group. In his book, Wirth (1945), a prominent sociologist, defines a minority group as a group of people who are singled out from other groups and receive different or unequal treatment because of their cultural or physical characteristics, and because of this, regard themselves as objects of collective discrimination. As the introduction in this paper demonstrated, left-handed individuals have met with tremendous levels of unequal treatment and discrimination. Subsequent articles create evidence that although much of the personal deprivation has subsided in modern society, there remains inequity in many facets of every-day life especially as it pertains to educational accommodation.

The National Assessment of Educational Progress states specific guidelines regarding accommodations for all students. The policy specifically makes mention of the provisions that all schools must make for equal educational access to students with special needs. Special needs are not limited to individuals with some mental or physical issue. It also states a need for inclusion of individuals with limited English proficiency being classified for special needs identification. These guidelines seem to open the door somewhat for possible inclusion of left-handed individuals in the government provision (NCES.ed.gov 2009).

Acknowledgement and possible re-classification of the need for educational accommodations for left-handed individuals creates an interesting paradox. If left-handed individuals were to be re-classified as a minority, should they then be afforded some level of federal funding?

Federal funding allocations, which divide money among varied and specific minority groups, seem to support possible inclusion of a left-handed provisional group. In 2009, the federal government allocated $5 billion in early and developmental programs to help children get a jump start on important basic skills. These skills included a range from proper writing to advanced motor skills. The government website made specific mention of the importance of learning these skills in early childhood so as to assist future success (USA.gov., 2009). Xu et al. (2007) in agreement with the federal assertions, maintained that early childhood exposure to gross motor skills could positively affect intellect. These two assertions again seem to support the notion that some portion of federal funding should be allocated for left-handers.

Additional funding by the federal government to other groups also seems to give cause to the possibility of creating a funding source on behalf of left-handed students. The Individuals with Disabilities Education Act (IDEA) ensures services to children with all levels and types of disabilities throughout the nation. With 12.2 billion in funding, this governmental law mandates that special, equal based provisions must be adapted for all American children in schools. There are illustrations, by national statistics, that support some of the imbalance regarding funding for some of these special needs groups in regards to equal attention being given for left-handers. There are approximately 2.5 million people in America, 1% of the total US population, who are classified as mentally retarded (Encyclopedia of Mental Disorders, 2011). In contrast, there approximately 30 million, 10 % of the US population, that are classified as left-handed (Pachioli, 2001). Despite the unbalanced discrepancy, percentage wise, between the mentally retarded and left-handers (far more numbers of left-handers), there is no delineation of federal assistance for the latter group. This assertion is not meant to suggest that left-handedness and mental retardation are somehow synonymous with each other, nor is this assertion somehow equating the needs of left-handed people with the far more serious needs of the mentally or physically disabled. Instead, the statistical references are meant to show some validation that the broad ranged definition of special needs used by the federal government does seem to give room for possible inclusion of left-handed students. (idea.ed.gov., 2009; USA.gov.,2009).

A final possible federal funding source that might give just cause for some sort of funding for left-handed accommodations in education is the gifted and talented program. Although it is significantly less funded than the previous groups that were examined, gifted and talented programs like the Javitz Education Program allocates funds to school districts to assist those students whose educational needs fall outside the boundaries of the larger student body. The argument could be made that left-handed students fall inside those same boundaries (USA.gov.,2009).

Teaching Handedness

Left-handed Motor Skill Performance

There are a plethora of relevant studies that correlate the disparagement between left and right-handed people in performing various gross motor skills. These studies add some credible evidence to the repercussions of inequity in education for handedness especially as it applies to sport related gross motor skills.

One such study by Gabbard, Hart, and Gentry (1995) looked at differences in various coordination levels between three groups: (a) right-handed children, (b) mixed-handed children (show no preference between either hand), and (c) left-handed children. The researchers used the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) to compare the three subject groups. The study centered its focus on both gross and fine motor skills of the upper sections of the body. Tests included assessment of upper limb speed and dexterity, response speed, visual-motor control, balance, coordination, strength, bilateral coordination, and running speed and agility.

Results showed significance differences between the right-handed children group and the mixed-handed and left-handed children groups in relation to their performance scores on the BOTMP. ANOVA results revealed that right-handed children had significantly higher BOTMP scores in all fine and gross motor skill areas tested. Researchers noted that they could at least partially attribute the disparagement in scores to the lack of left-handed demonstrations and instructions.

A second study by Giagazoglou, Angelopoulou, Tsikoulas, and Tsimaras (2001) examined the gross and fine motor skills of left-handed school children aged four to six. Using the Griffiths Test II, the researchers found that left-handed children scored significantly lower on all test subscales. They believed that these disparagements in early basic motor skills led to poorer future school performance. Without early pre-school interventions, the researchers believed overall motor skill levels for these children would be significantly negatively affected and in turn lead to overall poor school performance.

In support of the research findings by Gabbard et al. (1995) and Giagazoglou, et. al (2001), another study by Hiscock and Chapieski (2004) looked at how hand preference affected manual asymmetry and manual skill. Similar to the aforementioned research, results indicated that a disparagement existed in performance levels between right and left-handed children with right-handed children scoring significantly better. Accordingly, an earlier study by Guldner, Mader and Zeltner (1981) found that lack of training on the dominant hand hampered psychomotor performance. From these studies, it is posited that since most sport and physical education training is designed for right-handed children, their performances in most gross motor skills might be significantly hampered.

Both the Hiscock et al. (2004) and Guldner et al. (1981) research discuss how the lack of training of gross motor skills and the proper assessment of those skills negatively affects left-handed children. These studies also note the future negative implications that this lack of attention and accommodation can have on left-handed people in general. Without well-planned early intervention programs, a large group of children may fail to reach their full educational potential.

Kastner-Koller, Dieman, and Bruckner (2007) attempted to create a more valid test to accurately measure handedness preference and motor skills. Similar to the findings from Gabbard et al. (1995), this study's researchers agreed with the notion that most available performance-based motor skill assessment tests did not yield accurate scores for non-right-handed children. This disparagement had been addressed in an earlier study by Kastner-Koller, Deimann and Bruckner (2007) when they created a new motor skills assessment tool designed to more accurately test performance levels of all children. Known as the Viennese Development Test (WET), the test focused on visual skills and fine motor skills. The test proved to have a high reliability (r = .97) and was a more reliable indicator of both hand preference and fine motor skill levels.

Similar to Kastner-Koller, et al, Brown, Roy, Rohr, Snider, and Bryden (2004) considered the current testing methods as an indicator of gross motor skill levels in regards to handedness. Using the Waterloo Handedness Questionnaire, the Wathand Box, two pegboard tasks, finger tapping and grip strength tests, the researchers examined what effect handedness had on skill performance. Results showed that right-handers scored significantly better than left-handers on those tests that were gross motor skill indicators. On the grip test, which is a basic strength indicator, there was not a significant difference. It appears that strength, unlike gross motor skill acquisition, is inherent and is not learned. This seems to be yet another supportive indicator, that learned gross motor skills are impacted by educational methods that are equitably applied.

Garonzik (1989), in an earlier study, also considered the validity of performance testing for left-handers. Unlike the aforementioned research, he looked at performance levels of left-handed individuals once they had finished their early education. In particular, the study examined performance levels of operators in relation to control panel efficiency. Garonzik found that left-handed individuals scored significantly less efficient, especially during critical control situations, than their right-handed counterparts. Garonzik primarily attributed the differences in performance between handedness to the layout of the control panel that the operators were trained to use. Because the panel was created from a right-handed perspective made it challenging for a left-hander to work as efficiently as a right-hander.

Handwriting and Related Activities

There is only anecdotal empirical research regarding teaching gross motor skills to left-handed people. The research that is available primarily focuses on teaching handwriting. The oldest of these examinations into handwriting was done by Provins and Glencross (1968). In their study, they separated participants into two groups: professional typist and non-typist. Each group was then asked to perform several typing related exercises including spelling words and speed performance. The specifics of the exercises required both the professional group and the non-typist group to alternate use of hands to perform the activities. Accuracy and speed were monitored and compared using paired *t-test* and correlation tests. Results indicated that among the professional typists there was no significant difference in speed or accuracy from the dominant versus non-dominant hand in performing the exercises. The opposite was true among the non-typist group. Subjects in this group showed significant difference in both speed and accuracy in all exercises when using non-dominant hand.

Provins and Glencross (1968) theorized an interesting concept from the studies' results. Subjects that had had no formal typing training performed significantly better with their dominant hand. Concurrently, subjects that had had typing training and had had extensive experience and practice typing did not rely as heavily on their dominant hand. They postulated that if ample training could be garnered equally to both sides of the body then equal efficiency, muscle memory, and recall can be achieved. There seems to promising linkage between those assertions and the theorems of this current paper. The Provins and Glencross study somewhat validates the premise that if educators were able to find some way to equally learn and practice a gross motor skill using both dominant and non-dominant sides, we might be able to move one step closer to bridging the gap of educational inequity based on handedness. Perhaps some of the ideologies derived from the practice methods of typing could shed some light on a possible teaching method that could be used in teaching left-handers.

In a follow up study, Provins and Magliaro (1993) again used typing as the center point for assessing hand preference with performance. As was found in the earlier study, there was a significant difference in performance when using the non-dominant hand. It should also be noted that non-trained or learned performance activities, such as grip strength in this study, showed no discernable significant difference. This finding reinforced the concept that success in a learned gross motor skill activity is precipitated by training and balanced practice.

Drawing from earlier Provins' studies (Provins & Glencross,1968; Provins & Magliaro,1993), Laeng and Park (1999) found similar results in a research study of their own. Instead of using the typewriter, the researchers used the piano to examine how creating a different keyboard might affect performance in piano playing. Using a piano that had a reversed keyboard (pitch decreased from left to right), they found that left-handed people learning to play the piano for the first time had a significantly better performance than beginning right-handers. However, the study also found that left-handers that had learned to play previously on the regular keyboard had comparable performance levels with their right-handed counterparts.

There were several studies that used handwriting as a source for examining how to teach to handedness. The first of these studies was conducted Viachos and Bonoti (2004). They looked at possible differences in writing performance of left and right-handed children ages 7 to 12. Students were assessed on writing, copying, and writing to dictation. Results found that left-handers were significantly overrepresented among the poor writing group. Obvious disparagements in handwriting training from teachers to left-handed students were found to be largely responsible for the overrepresentation.

A follow up study by Bonoti, Viachos and Metallidou (2005) continued the exploration of handwriting serving as a catalyst toward detection and correction of handedness educational inequity. In this study, the researchers compared writing and drawing performance between right and left-handed children ages 7 to 12. Their results found strong evidence of two important items. The first was that left-handed students were overrepresented among the group that tested as poor hand writers. Evidence verified that little attention had been paid to left-handers in regards to proper handwriting technique.

The second item found was that there was a significant correlation between handwriting performances and drawing performance. This significant result not only allowed possible early analysis for detecting handwriting performance issues among students but also may serve as a means for creating accommodations for left-handed students. If good drawing skills lead to good handwriting skills, might it be assumed that having students' practice recreational drawing with both dominant and non-dominant hands could serve as a potential method for balancing education in regards to handedness?

Mirroring and Other Approaches

Some educators have begun to look at alternate methods for giving appropriate instruction to left-handed individuals. Many of these alternate methods center on mirroring and mirror tracing. One of the earliest researchers to look at alternate educational methods was Kelly (1997). Having noticed obvious differences in handwriting performance by some left-handed students, she created some possible corrective tactics that teachers could employ to assist their left-handed student body. Hand positioning, correct positioning of the pencil, and the type of pencil used were suggested as being good simple tips that teachers could easily install into their handwriting training. She discussed the possibility of extending such simple provisions to other skill related activities.

Like Kelly (1997), two additional separate sets of researchers looked at specific methods that could be employed to assist teachers in addressing left-handed students' needs. Both Winslow (2001) and Wenze and Wenze (2004) created lists of tips that could be used by teachers to better accommodate their left-handed student population.

Through repeated observations and empirical research, Winslow (2001) noticed certain trends among his subject groups. From these observed and recorded trends, he created a basic foundational list of tips that all teachers should make themselves aware of when teaching left-handed students. They include: (a) paper and pencil: allowing them to turn paper and hold pencils differently than right-handed students, but might require the teacher to experiment somewhat with how to demonstrate writing practices with their classes; (b) sensitive language, showing that there is no right or wrong way to perform a motor skill when it is applied to right or left handed students as improper verbiage can lead to loss of efficacy on the part of students; (c) cutting remarks that do not attribute left-handedness to clumsiness; (d) measuring, that is, providing enough instruments, such as rulers, for both the right-handed and left-handed students, and (e) classroom furniture to create a setting that can be easily navigated and is user friendly for left-handed students. Although these tips are, in general, written for classroom teachers, their central theme can be applied to physical educators too.

Wenze and Wenze (2004) also created a list of tips that teachers should take into account when teaching a left-handed student a gross or fine motor skill. This set of tips first includes being empathetic rather than sympathetic. It is undesirable for any student to be singled out for being different, whether he is left-handed or disabled. Teachers should also be very careful to choose appropriate wording; words like clumsy or awkward should be avoided at all costs. Teachers should also strive to create applicable demonstrations, as best as possible, for both right and left-handed students. Seating arrangements should also be taken into account. This includes having left-handed desks available and creating seating arrangements that appropriately account for left and right-handed elbows. Classrooms should be aligned so that both right and left-handed students are able to sit in class comfortably. Teachers also need to make sure that there are appropriate numbers of left-handed supplies like scissors, rulers, etc. They should also make provisions for left-handed students to seek additional attention or help if necessary. Finally, teachers should coordinate with left-handed students' parents on possible accommodation suggestions that might make their children more comfortable and able to thrive at school.

In coordination with their tip list, Wenze and Wenze (2004) added an additional caveat. They suggested the possibility of using mirroring as a solution for aiding in left-handed learning. Mirroring, as it pertains to writing, involves writing in a way that runs in opposite direction to normal and where the letters are reversed (Schott & Schott, 2004). Similar to the effect that occurred in the earlier Provins' studies (Provins & Glencross,1968; Provins & Magliaro,1993) and the Laeng et al. (1999) study in which forced use of non-dominant hand in a motor skill assisted the learner to more aptly learn that skill, Wenze et al (2004) looked at mirroring creating that same learning effect.

There have been several studies that looked specifically at mirroring as a possible teaching method that can accommodate handedness. The first of these was conducted by LeBarre and Harris (1999). Participants included 15 high school and college students. Participants took several tests that looked at the effect of mirroring on spatial ability and perception. Performance results were compared between left and right-handed participants. Results indicated that there was no significant difference in performance level between right and left-handed subjects upon completion of the mirror training methods. These results give some level of anecdotal support for using mirroring as a teaching method in addressing handedness.

Two articles give additional support for the use of mirroring. In the first study (Schott & Schott, 2004), the researchers looked at the direct use of mirroring as a method for teaching handwriting. By examining previously conducted case studies, the authors looked at similarities in results from these studies that might give evidence of the effectiveness, in regards to handedness, that mirroring might play in learning handwriting.

A recurrent theme was noticeable in the various case studies used in the Schott and Schott (2004) study. Mirroring seemed to be an especially helpful tool for learning handwriting among individuals with disabilities. These disabilities included mental retardation, stroke recovery, and dominant limb deficiency. Among most of the individuals included in the case studies, mirroring effectively aided in substantively improving handwriting. The authors of the article concluded that there is strong evidence that mirroring can be an effective tool for learning handwriting.

A final study took a broader approach. Herdegen and Ford (2004) examined at the effects that mirror-tracing had on motor skill acquisition. They wanted to know if mirroring could be used as a source for teaching a motor skill that could be used in substitution of a massed teaching method. Mirroring allows instructors to utilize a distributed spatial method of teaching. Distributed spatial teaching allows the instructor to use a smaller space to teach a motor skill and also allows longer engagement by the students to practice the skill. Herdegen and Ford (2004) found that this method of mirroring helped students of either handedness to improve, relatively equally, in tracing skills. From these results mirroring may be a viable exercise to improve the equity of left-handers in gross motor skill learning.

Summary

The preponderance of anecdotal evidence indicates a rather pronounced disparagement in the equity for both societal and educational issues in regards to left-handers. This disparagement is especially prominent in terms of education. In all educational avenues and subject areas, there has been little attention paid to this growing population group. As the numbers of left-handed individuals slowly continues to rise, a more serious addressing of the issues of this inequity will need to be addressed.

Little research is currently being conducted on how to assist in the creation of a more inclusive educational process for left-handers. Teachers are not currently trained or equipped to aid in this needed transition to this new teaching methodology. Currently, there is not even an appropriate assessment tool to gauge current levels or status of educational disparagement. With the current economic strain that many public school systems find themselves, it might be incumbent upon the federal government to acknowledge this disparagement and create a funding source to help move the process along.

As current literature forebodes, if we do not give appropriate acknowledgment of inadequacies within the educational system for left-handers and take steps to create effective change, this growing population group may find themselves at a huge learning disadvantage to their right-handed counterparts.

CHAPTER 3

METHODS

Participants

Participants consisted of 69 undergraduate students enrolled at the University of Arkansas, with an equal number of right and left-handers. There was an effort made to include an equal balance of males and females in the participant group. This balancing was done by an intake volunteer who alternated admission to the intervention between left and right-handed participants as well as male and female participants (see Appendix 7). The only pre-requirements that disqualified a participant from involvement in the study were prior experience with the sport of lacrosse. This pre-requirement was assessed by the intake volunteer through a basic questionnaire given before the participant began the activity (see Appendix 6). The primary focus of the study was a random sampling of university students in gross motor skill acquisition based upon handedness.

Instrument

Lacrosse was chosen as the gross motor skill on the basis of lack of knowledge of this sport by the participant group. This study was conducted in the southern portion of the mid-west. Lacrosse is not a popular or well-known sport in this part of the country. A 2008 survey by the U.S. Lacrosse Association found that although its popularity is slowly working its way into the south and mid-west, lacrosse is a sport whose overwhelming participation lies along the East Coast of the United States. The survey showed this unequal participation by region by giving the participation rates of Maryland and Texas. Maryland recorded having almost 51,000 players statewide while Texas recorded less than 5,000. The report also showed that few or no states west of the Mississippi have nationally recognized or sanctioned state lacrosse programs (US

Lacrosse.org, 2008). For the premise of the study to be effective, it was necessary to have a gross motor skill with which participants have no experience. Lacrosse fit that requirement.

Intervention

Pilot Study

To determine the distance participants would stand from the target, the size of the target itself, and the overall effectiveness of the procedures involved in the intervention, a pilot study was conducted. Eight volunteer subjects were used in the pilot study. Four of the subjects were right handed and four were left handed. Subjects came into the gym one at a time and were shown one of two demonstration videos. Half of the right-handers viewed a right-handed video demonstration while the other half were shown a left-handed video demonstration. The same alternating viewing method was done with left-handed participants. Each video demonstration utilized a modeling technique and included a series of cues which incorporated how to hold the equipment, how to position the body, how to shift body weight, and how to finish the shot with proper follow through. Both videos were recorded from three different angles (front, back, and side of handedness). After completing the pilot study, it was determined that the video demonstrations were not viable for use primarily because of the time restraints required of the participants. Secondarily, it was also determined from the pilot study that use of the videos did not appropriately mimic a physical education teacher instructing his class. For those reasons, it was decided that a live demonstration would be utilized to give a more reliable assessment.

In addition, both of the graduate students that agreed to participate as raters for the study subsequently agreed to sit through each participant's intervention and conduct their rubric analysis of form accuracy in live time. This was beneficial for both time conservation and a more accurate rater scoring.

To determine shot distance, each participant was given shot attempts at varying distances. After using closer and farther distances, it was determined that the standard distance of 10 meters from the target by the participant was most appropriate. This distance worked well as the default distance as participants were able to hit the target with some modicum of success but without inflated scoring totals. Further support for using 10 meters came in the fact that it is the distance of a penalty shot in lacrosse and is considered by lacrosse players and coaches as a standard distance for assessing lacrosse shooting accuracy. This was confirmed by conversations with several players on the University of Arkansas Lacrosse Club (Personal conversation, 2010). The target and distance used were similar in size, dimension, and distance of those used in two other studies (Landin, Hebert, Menickelli, & Grisham, 2003 & Menickelli, 2004) and were also assessing target accuracy using a gross motor skill. Although these two studies used frisbee and not lacrosse as their gross motor skill, the overall goal of the activity, target accuracy, was very close to that of this study. Also the general overall size of the target was similar to ones used by lacrosse teams to assess accuracy (Anacondasports, 2010). The difference in those at Anaconda Sports and the ones used in this study are the presence of concentric circles on the target with different point delineations. By dimensions then, and in likeness to the target dimensions in the Menickelli (2004) study, the target had the following measurements: center ring had a radius of 25 cm, with each concentric circle outside the bulls eye measuring an additional 25 cm from the previous outside line.

After completing the pilot study and as was mentioned previously in the intervention section of the methods chapter, it was decided by the researcher not to use the videotapes. The videotaping procedure could be used in future applications as a possible optional instruction method by right-handed teachers teaching left-handed students.

IRB approval was received from the University of Arkansas before the pilot study began (see Appendix 8). Informed consent was secured for each subject before their participation (see Appendix 4). Participants participated one at a time.

Outside the deletion of the videos, the rest of the original methodology remained intact. Half of the participants were shown a right-handed demonstration video while the other half were shown a left-handed demonstration video. An equal number of left and right-handers viewed each handed demonstration. As part of the demonstration, and before they began the activity, all participants were instructed to use their dominant hand while attempting the lacrosse shot. Using the dominant hand cue in the demonstration was a critical component of the applicability of the demonstration to the larger goal of the study. For consistency purposes, the same model was used in both demonstrations. The model performing the demonstration was an experienced physical education instructor who had extensive background in performing gross motor skill demonstrations, including lacrosse shots, with either hand. He was able to perform a lacrosse shot equally well and in the same technique with either hand.

After the demonstration, each participant was allowed two practice attempts of shooting at the target. Each participant then had five attempts to shoot the lacrosse ball with the lacrosse stick at the target. The combination or sum of these five attempts was used as the graded score for shot accuracy (Appendix 3). Shot form, which utilized a form rubric, used the five attempts in their totality to give an average overall assessment (Appendix 2). Two rater volunteers, who were both kinesiology doctoral students, watched each participants attempt in live time and rated them accordingly.

Only one participant at a time attempted a shot. This was done in an attempt to secure accuracy of assessment by the raters. Each participant's intervention process lasted approximately 10 minutes. Participants did not see other participants shoot.

Measures

There were two dependent variables for analysis in the study: target accuracy score, and body mechanics and technique. The first dependent variable, target accuracy score, was analyzed using a modified target. The target was circular in nature with a center point (bulls-eye) and four concentric circles surrounding it. Point values were awarded as follows: (a) 5 points for hitting center (bulls-eye), (b) 4 points for hitting the first concentric circle surrounding the center point, (c) 3 points for hitting the second concentric circle surrounding the first concentric circle, (d) 2 points for hitting the third concentric circle surrounding the second concentric circle, and (e) 1 point for hitting the final concentric circle that surrounds the third concentric circle. As previously mentioned, the pilot study helped in determining the size of the target. The center, bulls' eye had a radius of 25 cm and the subsequent rings had radii of 50 cm, 75 cm, 1 m, and 1.25 m respectively (Menickelli, 2004).

The second dependent variable, body mechanics and technique, was assessed using a rubric. The rubric assessed four components of the lacrosse shot. Those components included: (a) grip (hand placement on stick), (b) body positioning (including hand and arm position), (c) weight transfer, and (d) finish and follow through (see Appendix 1).

Procedure

Volunteers were secured from the general undergraduate student population of the University of Arkansas. The study used 69 student volunteers. All participants completed and signed an informed consent form for participation in the study. To maintain confidentiality, no personal information was recorded regarding the participants. Participants were not told what activity they were doing until they entered the gym to participate.

Assessment was based on two criteria. The first criterion was successful hitting of the target with the shot. The second criterion involved the use of proper body mechanics and technique in performing the shot. All shot attempts by the particiants were instantly rated for form, by the two raters, at the interventions. The target accuracy was also completed at the time of the intervention by the researcher.

Procedural order for all participants were as follows:

(a) Student volunteer participants entered gym with no other students (researcher and the raters were the only other individuals in gym); informed consent form had already been signed

(b) Participant watched the demonstration of a lacrosse shot

(c) Participant took two practice attempts of a lacrosse shot at the target

(c) Participant then attempted five lacrosse shots at a target

(d) Raters and researcher completed form rubric and target accuracy sheets

The two raters were chosen from kinesiology doctoral students and they were trained on proper Lacrosse shot form as well as how to use the rubric for assessment. Raters were given a rater sheet to assist their rating efficiency (see Appendix 1). To insure rater confidence, interrater reliability was used to ensure consistency. All categories and subcategories measured above .9. Total rubric scores rated .995 (p =.05). Because of the high rater agreement, all rater rubric scores were averaged and the average scores were used for statistical analysis.

Analysis of the Data

The following statistical approaches were used for each of the hypotheses and their subsequent assumptions. Means and standard deviations were computed for all groups on each measure. A planned comparison ANOVA was then run to check for significance between the two hypothesized participant groups (right-handers that viewed a left-handed demonstration and left-handers who viewed right-handed demonstration).

A correlation was then used to check for multicollinearity between rubric total and point total. A second correlation matrix checked for multicollinearity between the parts of the shot rubric. A 2 x 2 (participant handedness by model handedness) was used to test for a main effects and interactions on target accuracy score and the shot form score. A second 2 x 2 (participant handedness by model handedness) MANOVA examined the four components of the shot form rubric.

CHAPTER 4

RESULTS

The primary purpose of this study was to examine the effect of demonstration handedness on gross motor skill acquisition of left and right handed college students. In investigating this effect the following hypotheses were used.

(a) Target scores achieved by left-handers that view a right-handed demonstration will be significantly higher than the target scores achieved by right-handers that see a left-handed demonstration.

(b) Rubric scores on shot form achieved by left-handers that view a right-handed demonstration will be significantly higher than the rubric scores on shot form achieved by right-handers that see a left-handed demonstration.

For testing purposes, students were put into four groups:

(a) Left-handed individuals viewing a left-handed demonstration
(b) Left-handed individuals viewing a right-handed demonstration
(c) Right-handed individuals viewing right-handed demonstration
(d) Right-handed individuals viewing a left-handed demonstration

Students target accuracy scores and shot form rubric scores were the dependent variables. Within the rubric scores, subscale scores included grip, body positioning, weight transfer, and finish and follow through. The independent or fixed variables included subject’s true handedness and the handedness in which the demonstration was performed.

Means and standard deviations were calculated for left and right handed participants us for all variables. A planned comparison ANOVA was used to test the two research hypotheses for dependent variable significance between right-handers viewing a left-handed demonstration and left-handers viewing a right-handed demonstration. Additionally, a correlation matrix was used to check the relationship between the dependent variables. A 2 x 2 multivariate analysis of variance (MANOVA) based upon participant handedness and demonstration handedness, was used to determine overall significance between groups in relation to target accuracy and shot form.

Descriptive Statistics

Table 1 through Table 6 contains means and standard deviations for each participant group. Table 1 displays means and standard deviations for target accuracy scores for all participant groups. Table 2 displays means and standard deviations for total rubric score for all participants. Means and standard deviations for rubric grip scores are shown in Table 3. Table 4 shows means and standard deviations for the rubric body position scores. Weight transfer rubric scores are displayed in Table 5 while follow through and finish rubric scores are shown in Table 6.

Table 1

Target Accuracy Scores for all Participant Groups

Subgroup	N	M	SD
Right handed group	35	6.46	4.25
Right handed w/right handed demonstration	18	8.11	4.42
Right handed w/left handed demonstration	17	4.71	3.35
Left handed group	34	8.65	3.52
Left handed w/left handed demonstration	16	8.44	3.44
Left handed w/right handed demonstration	18	8.83	3.67

Table 2

Total Rubric Scores for all Participant Groups

Subgroup	N	M	SD
Right handed group	35	4.51	3.23
Right handed w/right handed demonstration	18	5.08	3.40
Right handed w/left handed demonstration	17	3.91	3.03
Left handed group	34	6.57	3.01
Left handed w/left handed demonstration	16	6.63	2.77
Left handed w/right handed demonstration	18	6.53	3.30

Table 3

Rubric Grip Scores for all Participant Groups

Subgroup	N	M	SD
Right handed group	35	1.96	1.37
Right handed w/right handed demonstration	18	2.06	1.35
Right handed w/left handed demonstration	17	1.85	1.43
Left handed group	34	2.22	1.17
Left handed w/left handed demonstration	16	2.16	1.26
Left handed w/right handed demonstration	18	2.28	1.11

Table 4

Body Position Scores for all Participant Groups

Subgroup	N	M	SD
Right handed group	35	.89	1.12
Right handed w/right handed demonstration	18	.75	1.07
Right handed w/left handed demonstration	17	1.03	1.18
Left handed group	34	1.90	1.22
Left handed w/left handed demonstration	16	2.03	1.16
Left handed w/right handed demonstration	18	1.78	1.30

Table 5

Weight Transfer Scores for all Participant Groups

Subgroup	N	M	SD
Right handed group	35	1.09	1.30
Right handed w/right handed demonstration	18	1.36	1.39
Right handed w/left handed demonstration	17	.79	1.16
Left handed group	34	1.53	1.18
Left handed w/left handed demonstration	16	1.44	1.03
Left handed w/right handed demonstration	18	1.61	1.32

Table 6

Finish Scores for all Participant Groups

Subgroup	N	M	SD
Right handed group	35	.6	1.15
Right handed w/right handed demonstration	18	.92	1.35
Right handed w/left handed demonstration	17	.26	.79
Left handed group	34	1.06	1.12
Left handed w/left handed demonstration	16	.95	.60
Left handed w/right handed demonstration	18	1.11	1.28

Univariate Planned Comparison Between Groups

A planned comparison univariate analysis of variance (ANOVA) was run to search for significance, among all dependent variables, between two of the participant groups. The two groups that were compared were between right-handed participants that viewed a left-handed demonstration, and left-handed participants that viewed a right-handed demonstration.

The planned comparison ANOVA revealed significance in both dependent variables. Target accuracy revealed significance levels of (F (3, 68) = 4.38, p = .007). Rubric form also revealed significance (F (3, 68) = 2.87, p = .043). Finally, significance was also found among the rubric subcategory of body position (F (3, 68) = 4.51, p = .006). Results are displayed in Table 7. For each set of tests, left-handers that viewed a right-handed demonstration scored higher than right-handers that viewed a left-handed demonstration

Table 7

Planned Comparison, Among all Dependent Variable's Between Right-handers That Were Given a Left-handed Demonstration and Left-Handers That Were Given a Right-handed Demonstration

Dependent Variable	df	F	p
Target Accuracy	3,68	4.38	.007
Rubric Form	3,68	2.87	.043
Grip	3,68	.36	.80
Body Position	3,68	4.51	.006
Weight Transfer	3,68	1.40	.25
Finish	3,68	1.96	.13

Correlation Matrix

After finding significance with the planned comparison ANOVA, follow-up exploratory testing was conducted. A MANOVA was run to search for main effects and interaction. Before running the MANOVA, a correlation between rubric total and point total was run to check for multicollinearity. Results showed a moderate correlation of r = .41. Since no multicollinearity existed, the two variables (rubric total and point total) were then analyzed using MANOVA. Table 8 displays the correlation results.

Table 8

Intercorrelations Between Scales

	Points Target	Rubric Total	Grip	Body Position	Weight Transfer	Finish
Points Target	1					
Rubric Total	.41	1				
Grip	.24	.63	1			
Body Position	.30	.76	.33	1		
Weight Transfer	.32	.67	.15	.43	1	
Finish	.32	.61	.20	.30	.27	1

Multivariate Analysis of Variance

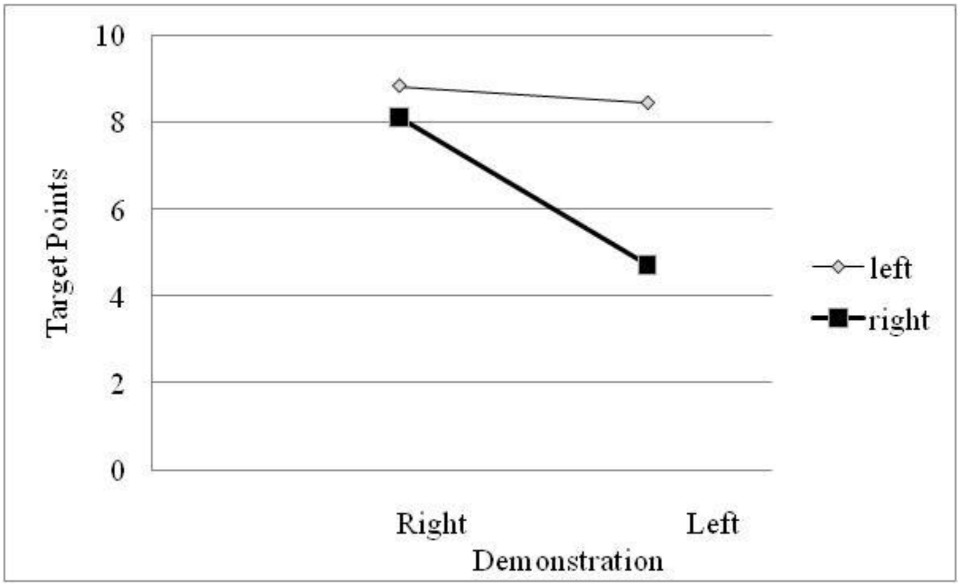
A 2 x 2 multivariate analysis of variance (MANOVA) was conducted to determine if main and interaction effects were present among participants. Alpha for the MANOVA was set apriority $p < .05$.

The MANOVA revealed that multivariate F's were significant. Participant's handedness revealed a main effect (F (2, 64) = 4.97, p = .010) as did demonstration (F (2, 64) = 2.17, p = .012). However, there was no multivariate interaction effect (F = (2, 64) = 1.40, p =.26). Figures 1 and 2 show the reported results.

Univariate testing showed that there was a main effect based upon handedness for both target total point (F (1, 65) = 6.04, p = .017) and rubric scores (F (1, 65) = 7.52, p = .008). Left-handed participants scored higher on total target point (M = 8.65, SD = 3.52) than right-handed participants (M = 6.46, SD = 4.25). Left-handers also scored higher on rubric totals (M = 6.57, SD = 3.01) than did right-handers (M = 4.51, SD = 3.23). Figure 1 illustrates these results.

Figure 1

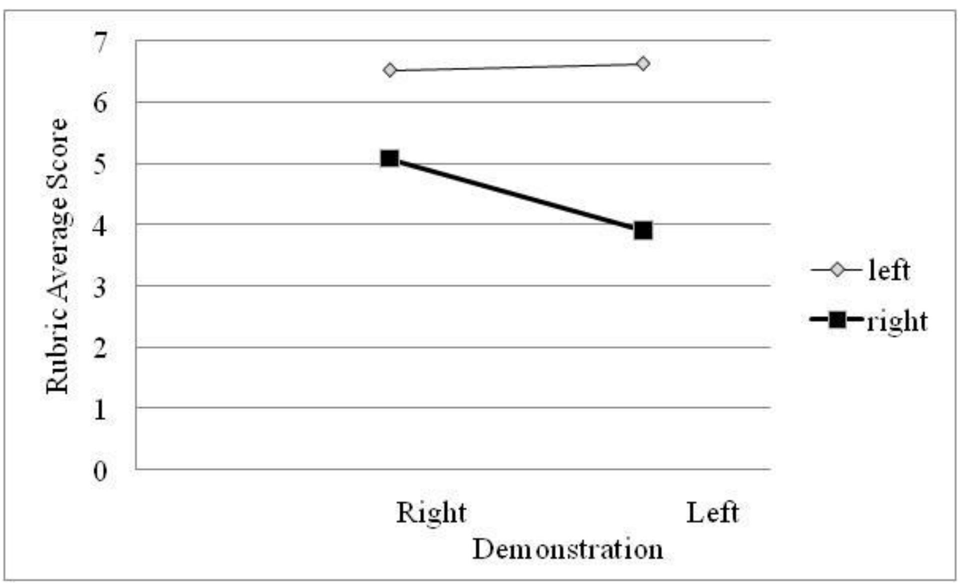
Demonstration Hand Effect on Target Point Totals



Univariate testing also showed a main effect based upon demonstration hand for target total point (*F* (1, 65) = 4.40, *p* = .04) but not for rubric scores (*F* (1, 65) = .50, *p* = .48). Left-handers scored higher in target total point scores (*M* = 8.83, *SD* = 3.67) than did their right-handed counterparts (*M* = 4.71, *SD*= 3.35). Rubric scores for left-handers were higher (*M* = 6.53, *SD* = 3.30) than right-handers (*M* = 3.91, *SD* = 3.03) but were not significant. Results are displayed in Figure 2.

Figure 2

Demonstration Hand Effect on Rubric Average Score



Follow-up Multivariate Analysis of Variance

Additional 2 x 2 MANOVA testing was done to determine significance between the four individual subscales that made up the rubric. As mentioned previously, the components that made up the rubric were: (a) grip, (b) body position, (c) weight transfer, and (d) finish and follow through. Only participant hand in relation to body position showed significance (F (1, 65) = 12.7, p = .001). Left-handed participants scored higher on the body position component (M = 1.90, SD = 1.22) than did right-handers (M = .89, SD = 1.12).

CHAPTER 5

DISCUSSION

The primary purpose of this study was to examine the effects that handedness has on acquiring gross motor skills among college age students. More specifically, it wanted to determine the effect viewing a demonstration in the non-dominant hand had on gross motor skill performance. Keeping in line with the primary purpose, the two groups that this study was most concerned with were right-handers that viewed the demonstration from a left-handed perspective and left-handers that viewed the demonstration from a right-handed perspective. The results are discussed in several sections that correspond first to the statistical results and then to some of those items that were addressed in the introduction and review of literature.

In relation to the first hypothesis (anticipation that the target scores achieved by left-handers that see a right-handed demonstration will be significantly higher than the target scores achieved by right-handers that see a left-handed demonstration), target accuracy scores achieved by left-handers who viewed a right-handed demonstration were significantly higher than those target accuracy scores achieved by right-handers who viewed a left-handed demonstration. Results from the second hypothesis (anticipation that the rubric scores on shot form achieved by left-handers that see a right-handed demonstration will be significantly higher than the rubric scores on shot form achieved by right-handers that see a left-handed demonstration), yielded similar results. Rubric scores on shot form were significantly higher by left-handers that viewed a right-handed demonstration than the rubric scores on shot form achieved by right-handers that saw a left-handed demonstration. Additionally there was significance found in the body position sub-category of the form rubric. Left-handers performed significantly better with their body positioning than did right-handers.

These results were not surprising when taking into account the age level of the participation group. As was mentioned in the review of literature, left-handed individuals spend a lifetime viewing virtually all demonstrated sport activity demonstrations in the opposite hand. At this point in their development, the brain has probably re-wired itself to transpose such demonstrations automatically. With few opportunities for right-handers to see a left-handed demonstration over the course of their life, it was expected that they would suffer mimicking a new skill that was shown to them by a left-hander. Results from this study support this suggestion as there was little difference in the mean scores between the two left-handed groups based on the handedness of their demonstration.

Additionally, it is not surprising that results show that left-handed subjects performed consistently significantly better on target accuracy than did right-handed subjects. The lack of interaction also serves as a supportive indicator that the high number of demonstrations seen in opposite hand by left-handers over the course of their lives by left-handers creates a non-significant effect in relation to its interaction with viewing a demonstration in dominant hand.

Results of this study allow for several assumptions. The first centers on learning a previously unlearned motor skill. As it applies to effectively executing a gross motor skill to achieve a desired outcome (shooting a lacrosse ball in proper form and hitting a prescribed target), evidence from this study indicates that left-handed college students learn gross motor skills more efficiently when viewing a demonstration of that skill in their non-dominant hand, than do right-handed college students who view a demonstration in their non-dominant hand.

A second assumption found from results in this study is that left-handed college students in general, not taking into account the handedness of the demonstration, were more apt to effectively perform the previously mentioned gross motor skill than were right-handed college students. This might be an indicator, as supported by Lareng and Park (1999) and Delisle, Imbeau, Santos, Plamondon, and Montpetit (2003), that left-handed people can eventually adapt and learn a new skill that is designed to be used from a right-handed perspective. As was shown in both of these studies, left-handed people were eventually able to adaptively learn a previously unfamiliar motor skill like playing the piano or using a computer mouse.

The real issue, then, is not if the skill can be learned, but the level that can be achieved by the left-handed learner. Anecdotal evidence of adult left-handedness from Left-HandedChildren.org (2006) found that left-handed students did not learn gross motor skills as effectively as did right-handed students. Countless testimonials in the article relay frustration by left-handed learners of the challenges involved in learning a skill designed for and taught by right-handers. The article concluded that the left-handed learner is generally not able to learn a skill as quickly or efficiently as their right-handed counterparts. Perhaps more adaptable teaching methodology use during instruction at an early age would result in left-handers achieving a higher level of ability on a specific gross motor skill.

With regards to prior research studies, results from this current study make several assertions. In regards to the motor learning process which includes modeling, much of what was theorized has been, in part, confirmed. As discussed by both Bandura (1976) and Artino (2008), students learned best and retained the most when modeling was performed by the instructor. More specifically, and in line with Glaser’s (1989) theory, student learning and retention was greatly enhanced by specific modeling that included demonstrations and cues. Although three of the four groups were able to effectively learn the skill, there was an obvious twist inserted with the left-handed participant group. Results indicate that any demonstration, regardless of its handedness, is adequate for left-handed college age students to effectively learn a new sport related gross motor skill. This does not hold true among the right-handed participant group. Confirmations of these results were seen in the statistical significance shown between the two hypothesized groups (right-handers viewing a left-handed demonstration and left-handers viewing a right-handed demonstration).

Centering on the premise, then, that specific demonstration and cues aid in learning gross motor skills, it would seem that certain teaching practices might need to be addressed. Is there an educational issue, within current school teaching practice, in regards to equitable learning access for left-handed students? The results from this study seem to indicate that at the college level, many students have learned adaptive skills to aid in their learning gross motor skills. But as qualitative research conducted by Winslow (2001) and Wenze and Wenze (2004) maintained, much of this adaptive learning on the part of left-handed students have come from students' parents, not from their teachers. This lack of at school support, they warn, creates a disparaging situation for those students who do not have the parental support to teach them such skills.

The Winslow (2001) and Wenze and Wenze (2004) studies help validate the need for why educational institutions should take a hard look at their physical education teaching models, in regards to handedness, despite the results found in this study. Two studies seem to display that age plays a role in left-handed sport related gross motor skill acquisition. Both studies contradicted the findings of the present study.

Gabbard, Hart, and Gentry (1995), found significant differences between right and left-handed children in relation to fine and gross motor skills in the upper body. Results indicated that right-handed children performed significantly higher on the tested skills than left-handed children. In this study, the researchers used the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) to assess the child participants.

Furthermore, Giagazoglou, Angelopoulou, Tsikoulas, and Tsimaras (2001) used the Griffiths Test II for assessment. In their study researchers tested several gross motor skills among a participant group of four to six year olds. As with the Gabbard, et al. (1995) study, left-handed students performed significantly lower than their right-handed counterparts.

The data in the current study came from a specific age group (college age students). Its results are in contrast to results done by other researchers. As mentioned previously, the differing results between the current study whose participant group is made up of college students and the comparative studies that use young children for their participant groups should serve as an example of a likely reason for the contrasting results. One possible reason may be that younger left-handed children who have not received gross motor skill instruction in their dominant hand from either teachers or parents will struggle to make equivalent results to that of their right-handed counterparts who see most demonstrations in their true dominant hand. In addition, the contrasting results should serve as an indicator that the neural pathways in the brain have the ability to adapt. If we accept the assertions made in the Winslow (2001) and Wenze and Wenze (2004) studies, there is a dilemma for those left-handed students who do not receive adequate gross motor skill instruction from either their parents or their teachers. If appropriate instruction is not given to these children because of either lack of knowledge or desire by the responsible adults, then there is the real possibility that some significant number of these left-handed children might be hurt for the future in regards to their motor skill acquisition. Referencing again to the foreboding assertions made by Wenze and Wenze (2004), if it is acknowledged that there is a deficiency in the teaching practice toward left-handed students, what needs to be done to correct or improve this issue?

Earlier studies by Walker (1998) and Montgomery (1996) experimented with actual interventions that addressed possible teaching practices designed to create a more balanced educational experience for left-handed students. Their interventions involved the addition of teacher aids to help left-handed students. It was found that such interventions led to much higher skill acquisition among left-handed students.

An additional study by Johnston, Nicholls, Shah, and Shields (2009), which found significant handedness educational deficiencies, added specificity to the issue by identifying specific developmental outcomes that are likely to occur from such one-sided teaching practices. Results from this study inspired the English school system to take a hard look at the equity of its educational system. They have begun teacher training seminars designed to educate teachers to be more mindful of their left-handed students and facilitate discussions on best teaching practices in regards to handedness.

The results from the aforementioned assessment tests mimic the non-statistical analogies garnered with the researcher's own daughter and which served as the pilot for this dissertation. Using the Miller's Test for Preschoolers, the researcher found noticeable differences in outcomes between the researcher's daughter and a playmate who was the same age but was right-handed. In the most basic of skills tests the researcher's daughter scored significantly lower than her friend. The researcher found this odd as having spent much time with each little girl and having taught both in a cooperative home school for over a year, it was apparent that their gross and fine motor skills were not dissimilar in scope or ability. Further, when a particular assessment test found in the Miller's Assessment was reversed, a very different and improved result was seen. Although, this tacit test was amateur in its conducted scope, it illuminated to the researcher the relative ease it took to initiate an equitable left-handed version and produce more a representative score. It seems that similar tactics for teaching young left-handed students sport related gross motor skills could also be achieved with relative ease.

Addressing the issue of supplying an equitable physical education teaching model for young left-handed students has validity in science. Berger and Thompson (1995) contend that it is important to learn basic gross motor skills of all types, including sport-related skills, at an early age. They maintain that most people are hardwired in regards to most basic motor skills long before they are adults. Some of these gross motor skill developmental hardwires begin as early as five years old. By adolescence, many peoples' brains are set to a level that would make it very difficult to learn a new basic gross motor skill from their dominant side and virtually impossible to learn it using the opposite hand. This reason is why most switch hitters in baseball learn to hit from both sides of the plate as children and not as adults. Being physically hardwired at so early an age creates a two-pronged conundrum for those left-handed students who do not receive proper instruction at school and do not have the parental support to instruct them at home. Instructors cannot learn to instruct the skill in opposite hand, and students cannot learn the skill when seeing it in their non-dominant hand. This situation would seem to pose yet another problem in regards to instruction. As was evidenced with the poor performance by right-handers viewing a left-handed demonstration, the question arises of what issues might arise from a left-handed physical education teacher. With right-handers making up over 80% of the population a huge deficit in learning would most likely occur if they were not able to give appropriate demonstrations using the opposite hand.

With school budgets regularly slashed it would seem impractical that many school districts would be able to fund additional aids or training programs for their teacher to address handedness. The question could be argued of whether a re-classifying of left-handed students to some level of education grouping as a minority might by warranted. As was mentioned in the review of literature, the Wirth (1945) definition of a minority group:

> “a group of people who are singled out from other groups and receive different or unequal treatment because of their cultural or physical characteristics, and because of this, regard themselves as objects of collective discrimination.”

seems to be relatively in line with left-handed individuals which and adds background support for a re-classification.

Again referring back to the review of literature, it has been shown that from a statistical standpoint left-handers comprise a much larger percentage of the total population than do all other current minority or disability groups combined (Encyclopedia of Mental Disorders, 2011; Pachioli, 2001). The prospect of re-classifying left-handers as a minority group is a slippery slope. As was previously stated, this paper makes no assertions nor does it have any desire to classify left-handedness as a disability. The comparisons that are suggested here are only meant to create a dialogue and examination of current teaching practices and federal funding for left-handed educational opportunities. With over 12 billion dollars in funding (USA.gov., 2009) allocated to satisfy the Individuals with Disabilities Education Act (IDEA) the question could be asked if being left-handed justifies a piece of the multi-billion dollar federal government pie. (idea.ed.gov, 2009).

Little empirical research has been conducted on teaching motor skills to students in opposite hand. Much of the existing anecdotal research in this area has been centered on teaching handwriting to both right and left-handed students. A 1968 study by Provins and Glencross and a subsequent follow-up study by Provins and Magliaro (1993) looked at how left and right-handed students performed with both handwriting and typing after receiving a brief instruction. Results indicated the possible benefits that might be gained from instruction in opposite hand.

Additional studies by Vlachos and Bonoti (2004) and Bonoti, Vlachos and Metallidou (2005) linked poor handwriting results among 7 – 12 year old left-handed students to lack of instruction by the teacher. It further concluded that left-handed students who were given a left-handed handwriting demonstration performed comparably to right-handed students. This seems to somewhat validate the notion that left-handed pre-school and elementary school children that receive gross motor skill demonstrations from the left side might be achieve a higher level of learning and performance.

Some researchers have looked at alternate methods of instruction of motor skills for pre-school and elementary school level left-handed students. Kelly (1997) created a lose template of representational instruction with corrective checkpoints. Centered around teaching handwriting, she suggested that instructors could perform a handwriting demonstration in their non-dominant hand without actually writing. Left-handed students would be able to see the basic arm and hand position as well as how the pen was being held. Corrective feedback could then be given to aid the left-handed student on how to properly write.

Additional studies by Winslow (2001) and Wenze and Wenze (2004) also considered solutions for teachers to help left-handed students learn. Both studies created a foundational list of steps teachers could take to aid in the teaching/learning process. The list ranged from teacher patience and individual instruction to having appropriate left-handed supplies like left-handed scissors.

An alternate method for instructing left-handed students was first suggested by Wenze et al. (2004), and subsequent studies by LeBarre and Harris (1999), Schott and Schott, (2004), and Herdegen and Ford (2004). Using varying versions, researchers suggested the use of mirroring as an aid to teaching left-handed students. Statistical analysis results seem to validate that some form of teaching in reverse fashion can be beneficial for left-handers to acquire certain motor skills.

Post examination of the present study reveals several limitations. Sample size and method of participant selection were the most prominent of these limitations. Although there were approximately the same number men and women volunteers in all four participant groups, for consistency purposes, it might have been better to have all participants come from the same gender.

Future Research

Results from this study should lead to further investigative assessment on how gross motor skill acquisition is effected by demonstration handedness. A follow-up study with similar parameters but with a much larger participant group should be employed. It might also be interesting to find another uncommonly used gross motor skill (like lacrosse) to use in the study to see if similar results would be garnered.

Additionally, a series of similar studies, as the present one, should be done on a variety of different age groups (grades 1 – 6 or even younger). Replicating this research study with younger, wide-ranging age groups could show dramatically different results. Pinpointing the age left-handers actually acquire the ability to transpose a right-handed demonstration into something they can convert into usable data could generate motivation by educational programs to assure certain important motor skill benchmarks are learned by left-handed students before their brains become hardwired. Specific time periods that are needed for physical education interventions could be pre-planned to insure particular benchmarked gross motor skills are learned in an age appropriate manner.

Performing the study with all male and all female students might also yield interesting results. Physical education and athletic programs for women have only moved toward equity since Title IX in 1972. It would be interesting to see if there is a difference in how left-handed boys and girls perform with similar instruction.

Conducting a study that observed motor skill acquisition, over a range of age groups, in which the physical education instructor was left-handed might also generate interesting results. Since the left-handed instructor, from a learning perspective, has most likely viewed motor skill demonstrations from the right-hand, it would interesting to see if they would be able to give appropriate demonstrations to right-handed students. Perhaps, because they have had to mentally invert most motor skill demonstrations to learn it themselves, they will be able to adequately demonstrate it reasonably well in either hand.

Finally, conducting a follow-up study using the videotapes that were to be a part of this original study might yield interesting results. Use of videotaped demonstrations, such as the one that was done in the initial stages of this study, might serve a possible alternate teaching method for left-handed students.

Conclusions

The purpose of this paper was to see if there was a difference in how people learn and subsequently perform a gross motor skill based upon their handedness and the handedness they view a demonstration of that skill. Planned comparison ANOVA testing revealed that left-handers viewing a right-handed demonstration performed significantly better in target accuracy and shot form than did right-handers viewing a left-handed demonstration.

MANOVA testing revealed two additional important outcomes. The first was that as a whole, left-handed participants performed significantly better on target accuracy than did right-handers. Secondly, it revealed that there was no interaction between the groups in relation to their own handedness and handedness of the demonstration handedness.

Finally, this study should not serve as an affirmation that there is no need to examine and adapt physical educational based upon handedness. The fact that left-handed students did well with the lacrosse activity suggests only the fact that their brains, by the time they reach college age, have created a neurological transposing ability. This finding was in direct contrast to the anecdotal results found with the researcher's daughter and that were reported in several recent supportive studies. Instead, and in conjunction with the current relevant literature, the results should indicate a need for further research into the teaching models for sport-based gross motor skills. It should not be expected or assumed that parents with left-handed children bear the responsibility of educating their children in basic gross motor skills whether it is in handwriting or throwing a baseball. It is beholden on us, as educators, to strive for teaching processes that reach all students regardless of age or handedness.

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APPENDIX 1

<u>Criteria and Levels of Performance of Lacrosse Shot</u>

1. Grip
    a. (3) Hands spread with dominant hand near basket and non-dominant hand near bottom (hand 1/4 way up from bottom)
    b. (2) Dominant hand on top but not near basket and non-dominant hand below dominant hand on staff but not near bottom
    c. (1) Poor spacing of hands but in proper arrangement (dominant on top non-dominant on bottom)
    d. (0) Dominant hand and non-dominant not in proper position

2. Body position
    a. (3) Non-dominant foot aimed toward target, body turned sideways with dominant hand raised above shoulder
    b. (2) Proficiency of 2 of the above 3 criteria (foot aim, body sideways, hand over shoulder)
    c. (1) Proficiency of 1 of the 3 above criteria (foot aim, body sideways, hand over shoulder)
    d. (0) Proficiency of none of the above criteria (foot aim, body sideways, hand over shoulder)

3. Weight Transfer
    a. (3) Weight starts on back foot and is shifted toward front foot during the shot
    b. (2) Weight starts on back foot but there is no weight shift to front foot during the shot; weight shift happens after the shot
    c. (1) Weight starts on back foot with no weight shift at all
    d. (0) Weight does not start on back foot or shift to front foot; weight is flatly distributed between both feet during shot with no weight transfer

4. Finish
    a. (3) Follow through by letting throwing arm come across body to opposite side with full extension. Basket/stick points at intended target with basket down and balance is maintained.
    b. (2) Proficiency of 2 of the above 3 criteria (Follow through, Basket/stick pointed toward target, balance maintenance).
    c. (3) Proficiency of 1 of the above 3 criteria (Follow through, Basket/stick pointed toward target, balance maintenance).
    d. (0) Little to no follow through. Basket/stick doesn't really point toward target. Complete balance not maintained.

APPENDIX 2

Dissertation Form Rubric

Rater # ________________

Handedness ________________

Demonstration Hand ________________

Gender ________________

Subject # ________________

Cue	Average of Attempts (0-3)
Grip	
Body Position	
Weight Transfer	
Finish	
Total (0-12)	

APPENDIX 3

Target Acquisition Computation Sheet

Participant Hand ____

Demo Hand ____

Cue or no Cue ____

Subject # _______________

All attempts scaled from 1 (low) to 5 (high)

Attempt 1 _____

Attempt 2 _____

Attempt 3 _____

Attempt 4 _____

Attempt 5 _____

Total _____

APPENDIX 4

Informed Consent

Title: Effect of Handedness on Gross Motor Skill Acquisition among College Undergraduates

Researcher (s):
Anthony Parish, MS Bio-Behavioral Science, Graduate Student
Cathy Lirgg, Ph. D., Faculty Advisor
University of Arkansas
College of Education and Health Profession
Department of HKRD
308 HPER
Fayetteville, AR 72701
479-575-2976

Description: The present study will investigate the effect that handedness has on gross motor skill acquisition. It is important to the integrity of the study that you have not had any significant exposure to lacrosse. You will be shown a video of a lacrosse shot. After seeing the video you will attempt lacrosse shot at a target. You will have five attempts at the target. Your attempts will be videotaped for analysis later.

Risks and Benefits: The benefits include contributing to the knowledge base of the effects that handedness plays in acquiring gross motor skills. There are not anticipated risks to participating in the study.

Voluntary Participation: Your participation in the research is completely voluntary.

Confidentiality: You will be assigned a number that will be used to record data. All information will be recorded anonymously. Only the researcher will know your name. All videos of your participation will be destroyed after the data is analyzed.

Right to Withdraw: You are free to refuse to participate in the research and to withdraw from this study at any time. Your decision to withdraw will bring no negative consequences -- no penalty to you.

Informed Consent: I, ____, have read the description, including the purpose of the study, the procedures to be used, the potential risks and side effects, the confidentiality, as well as the option to withdraw from the study at any time. Each of these items has been explained to me by the investigator. The investigator has answered all of my questions regarding the study, and I believe I understand what is involved. My signature below indicates that I freely agree to participate in this experimental study and that I have received a copy of this agreement from the investigator.

____

Signature Date

APPENDIX 5

Are you <u>Left Handed</u>?

Do you want a FREE Chick-Fillet Sandwich or free chocolate?

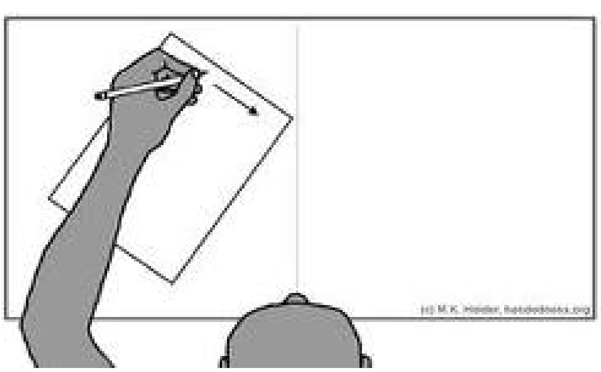
If you answered yes to these questions, we would like for you to participate in our **<u>RESEARCH STUDY</u>** in handedness. It should take about 15 minutes of your time.

Free Chick Fillet sandwich coupon or chocolate bar for ALL left-handed volunteers….First come first serve to first 35 respondents

Wednesday November 17^{th}

4-5pm

HPER Room 320



APPENDIX 6

Participation Survey

Subject # _______________

1. Have you ever performed a Lacrosse shot or pass? (Answer Y or N) _____

If you answered yes to question 1 you are finished.

If you answered no to question 1 continue on to question 2.

2. Are you right handed or left handed? (Answer R or L) _____

APPENDIX 7

Participation Tally Page

Right-handed subject with Right-handed demonstration

Right-handed subject with Left-handed demonstration

Left-handed subject with Left-handed demonstration

Left-handed subject with Right-handed demonstration

APPENDIX 8

July 15, 2010

MEMORANDUM

TO:	Anthony Parish
	Cathy Lirgg
FROM:	Ro Windwalker
	IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	10-06-702
Protocol Title:	*Effect of Handedness on Gross Motor Skill Acquisition among College Undergraduates*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 07/15/2010 Expiration Date: 07/14/2011

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Compliance website (http://www.uark.edu/admin/rsspinfo/compliance/index.html). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

If you wish to make *any* modifications in the approved protocol, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 120 Ozark Hall, 5-2208, or irb@uark.edu.