Lateral Dominance

and

Second Grade Reading Performance

THESIS

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by

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ABSTRACT

The purpose of this study was to discover if second grade students having a unilateral dominance will be academically higher in reading than their bilaterally dominant, or mixed laterally dominant classroom peers.

Two separate t-tests were used to test the research questions presented in this study: a) Will there be a statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the bilateral dominant group on a standardized reading achievement test? b) Will there be a statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the mixed dominant group on a standardized reading achievement test?

Initially, the differences between two physical lateralities (unilateral and bilateral second grade students) and their standardized reading achievement scores were established. Based on a standardized reading achievement test (raw scores), the t-test showed that there is no statistically significant difference between the means of unilateral and bilaterally dominant second graders.

An additional t-test revealed that there is no statistically significant difference between unilateral and mixed laterally dominant second graders. These findings are based on raw scores from a standardized reading achievement test.

I certainly want to thank Dr. Begy and Dr. Smith for their patient assistance. Dr. Ribble; your work with figures should never go unnoticed.

I appreciate students from Plank Road North Elementary School (Webster Central School District in Webster, NY), and Indian Landing Elementary School (Penfield Central School District in Penfield, NY). Without their professional courtesy and administrative support, I would have missed the opportunity of working with a great group of students.

For Kyle, Erin and my "wif" Mary;
the paperwork is finished, NOW it's time to play. I-L-Y all.

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Chapter I

Statement of the Problem

Ideally every teacher and parent hopes to have his/her students ready, willing and able to attend school the first day of kindergarten. Hopefully the child has had not only breakfast that first school day, but has been provided well balanced meals daily. The everyday surroundings of the developing student, including the neurological influences influenced by heredity, environmental conditions of maternal-fetus nutrition, cerebral development, posture in utero, and learning following birth are vital toward academic success.

The first days of school quickly become months, then years. In today's society there are ways that classroom teachers may assist students who may have identifiable deficits. However the professional teaching staff must be able to identify the students' deficiencies in order to remedy the learning difficulty.

As informal classroom observations suggest the need for help, elementary school teachers are constantly identifying students who are not getting enough sleep, who are not eating nutritious foods, and perhaps most often, students who sincerely try to recall information accurately from one day to the next, but just cannot.

One of the major aspects of a student's academic success may be attributed to success in his/her own individual neurological system and developmental growth pattern. The ability to identify a student who has been supplied with the basic developmental needs for proper growth, but continues to lag behind age appropriate peers should be examined from an age appropriate perspective.

Purpose

The purpose of this study was to discover if second grade students having a unilateral dominance will be academically higher in reading than their bilaterally dominant, or mixed laterally dominant classroom peers.

Null Hypotheses

H_o^1 There will be no statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the bilateral dominant group on a standardized reading achievement test.

H_o^2 There will be no statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the mixed dominant group on a standardized reading achievement test.

Definitions

Laterality -
the habitual use of one hand, foot or eye in preference to the opposite member
(Oxendine 1968, pg 305)

bilateral dominance -
performing an entire physical task using one preferred side of the body, followed by a second task performed entirely by the opposite side of the body

mixed lateral dominance -
using both sides of the body equally well; having no preference in a series of physical task performances

unilateral dominance -
having a clear majority of physical tasks performed by one preferred side of the body

Need for the Study

Each individual student grows and ventures through neurological, physical, and emotional developmental stages at unique rates. There are general guidelines that pediatricians, teachers, and parents may choose to follow, but each student progresses at his/her own pace.

This study accepts and acknowledges various student differences. For example, that some students may not be sleeping enough, or that they may not have an opportune, safe place to play at home (for physical development). Many of today's children may not be getting the nurturing or encouragement they require for developing an appropriate educational foundation. Some students may simply be watching too much television. But even when every possible fundamental stage has been acquired, some students may not be physically or neurologically ready to compete with their academic peers. It could be detrimental to beginning elementary aged students, to attempt an overwhelming academic task they are not mentally, or physically prepared to complete.

Testing for lateral dominance during the early elementary years, and comparing the students who have been placed into one of three previously defined 'dominant' categories (unilateral, bilateral, or mixed lateral), could

provide insight into the reading readiness levels of age appropriate boys and girls.

Limitations

During this study one of the limitations was working with very young second graders in a very short amount of time. To add strength to the study, it should be repeated to validate the raw data and the findings. The subjects were from a variety of Western New York elementary schools and were age appropriate for the second grade.

Each student was accurately tested for lateral dominance in approximately two minutes. Individual student test anxiety must be taken into account. The students were working with someone they had never seen before (although testing near or in their classroom, and introducing myself to the class before individually testing appeared to help). How the students were feeling on that day, physically and emotionally (just after the year end holiday break) could vary the test data.

Chapter II

Review of the Literature

Purpose

The purpose of this study was to discover if second grade students having a unilateral dominance will be academically higher in reading than their bilaterally dominant, or mixed laterally dominant classroom peers.

Defining Laterality

Laterality is a choice, whether conscious or instinctive, in utilizing one of two equally functioning body parts. Oxendine (1968, p. 305) defined lateral dominance as "the habitual use, in unilateral motor tasks, of one hand, foot, or eye in preference to the opposite member." For example, every person demonstrates hand laterality on the basis of which hand he/she uses to successfully complete a variety of tasks. Physical dominance may also be observed and measured while chewing, smiling, winking and a variety of other tasks. Physical laterality is exhibited by an individual choice between two body parts (the left or the right hand, the right or the left foot...). The degree of laterality is observed while a subject performs complex maneuvers, demonstrates body strength, or maybe displays coordination.

If a subject is unilateral, the tests are almost always successfully completed by one side of the body. The dominant hand, eye, ear, foot and so on, are either from the entire right or the entire left side of the body. The separate body parts all work together so the one side may finish the task. A person put into this classification is rare. Very few people are totally right or left dominant throughout their entire physical being.

In some instances, bilateral dominance (also known as being ambidextrous) occurs. If the subject attempts one job using the entire right side of the body, then works on an equally challenging task (totally using only the left side of the body), that person is said to be 'bilateral'. This group is also relatively few in number. Most people will fall into the next classification.

The majority of people use both sides of the body in a mixed fashion for the majority of their everyday tasks. The coordination of the right and left hand while driving is crucial for even the occasional driver. Most individuals for example, will use cross dominant body parts simultaneously. For example, the left eye, right hand, left hip or right foot may all be dominant while a person is waiting in line at a grocery store. A person crossing over, or mixing the body sides would be labeled exactly that, a 'mixed', or 'crossed' lateral. Gesell (Gesell & Ames, 1947) concluded a study of young children who

made significantly greater use of one eye in a more dominant way than they did with their hands. These subjects would be identified as 'cross dominant' or 'mixed dominant'. The subjects maintained one dominant eye, while frequently switching hands for a variety of jobs. In this group, subjects will tend to switch from side to side for observable laterality tasks. Simply stated, the individual choice of eye, foot, ear and so on, we chose to use helps determine our unique individuality and our unique laterality.

Some of the previous laterality studies involving the classroom (rather than the playing field) atmosphere, utilized college students. One problem concerning the testing of college students is they all have completed puberty and have clearly established their individual laterality. College students have traditionally spent the last 17 or 18 years experimenting, identifying, and practicing their preferences while completing physical feats and establishing muscular habits. It should be noted that these typical college students have already been accepted into a higher academic program in spite of possible severe laterality dysfunctions. They could be successful in school while functioning as severely mixed-laterals or bilateral individuals.

As a young child constantly switches laterality between hands (or other body parts), the communication to the cerebral cortex also switches (Gesell & Ames, 1947). The physical

portion of the body will respond to commands from the brain. If tests and observations reveal an inconsistency between tasks that are alike, 'mixed laterality' or 'crossed laterality' occurs. The more switches or lack of established patterns there are while retrieving memory, more effort by the student will have to be exerted to relearn educational material. Unconsiously, the student is hoping to establish and utilize a new, more permanent neurological pathway.

The notion of young students having poor reading skills while displaying inconsistencies of laterality (both manual and neurological), is one that has appeared in past literature (Dearborn, 1929, 1931, 1933, 1939; Gesell & Amatruda, 1941; Orton, 1937).

This study was based upon the laterality evaluation of three different body parts in second grade students. The first body part examined is also the first physically for a person to establish, the eyes (Miller, Keller, & Stryker, 1989). The second body part is the easiest to evaluate, the hands (Oxendine, 1968). The final body part evaluated here, also happens to be the farthest limb in terms of physical distance from the brain. It is used habitually for almost every step of physical development, the feet.

Correlations between the preferred hand and foot are higher than between any other two body parts (Coren & Kaplan, 1973; Poran & Coren, 1975, 1976, 1978 and 1979). The eyes

were chosen for evaluation in this study, simply because they develop first and frequently do not change after the first few months of birth (Miller, Keller, & Stryker, 1989).

Eyedness

The dominant eye is the eye which locates and identifies the sighted object first, assisted by the less dominant eye. The term 'ocular dominance' or 'eyedness' refers to the dominant eye of the pair. Sighting dominance rather than acuity (focusing ability) is a more direct reflection of individual eye preference. Overall, it is reported that approximately 75% of the American population is right-eye dominant (Sinclair & Smith, 1957).

Eye dominance has been related to hand dominance by Durost (1934), and Flick (1966). It has been theorized that the difference between eyedness and handedness in the later years of a person's life, is due to social and environmental pressures. Eye dominance is usually selected at birth and rarely changes after the first few months (Miller, Keller, & Stryker, 1989).

Under conditions using binocular vision, both eyes do not contribute equally in providing a stable visual perception. This simply means that although both eyes clearly work together, there is a 'lead' eye and a 'secondary' eye. The ability to see the object in question clearly is not always the initial

objective. To begin, the student must be able to identify and locate the object. The eyes will then almost instantly focus and evaluate the object. As in the world of sports, a baseball hitter will first locate a pitch, then identify the ball speed and rotation. All of this information will help adjust his swing appropriately. Adams' (1965) study of unilaterals and mixed laterals while playing baseball is one example. If a player was unilateral, he/she would be able to identify the ball a split second faster, also allowing the evaluation of the pitch to begin earlier. The unilateral baseball players simply performed better than the mixed dominant players. For those athletes, the ability to use the same side dominant eye and hands was a benefit.

How could a classroom teacher identify the dominant eye in any student? From a distance of approximately ten feet, instruct the subject to point at an eye level, two inch diameter dot. It is important to note and observe if the student strains to see the dot, or closes one eye to help focus. Using the right hand to point, if the subject does not cross over the body's midline (right hand - right eye), that would be a clear implication the right eye is dominant. To double check, ask the subject to identify the dot a second time using the left hand. As he/she points again, the subject's hand should cross the midline of the body. The subject will align the left hand with the right eye (if he/she is right-eye dominant).

Clearly the opposite would be true if the subject were left-eye dominant. If the subject is left-eye dominant, he/she will align the left hand fairly straight while pointing, and the right hand will clearly cross over the midline of the body. The closer the subjects are to the physical midline of their own body, the more bilateral or mixed laterally dominant those individuals may be. If the subject clearly crosses the midline while pointing with both hands, he/she may not have an established dominant eye (Springer & Deutsch, 1985).

Local optomistrists use a similiar process for identifying eye dominance. Dr. Susan Yorks, an optometrist in Webster, NY provided this insight toward eye dominance detection. She has been highly successful with a method taught and explained through her optometry professors. Instruct the patient to extend both palms straight outward from the body. The subject should be able to form one small circle between both thumbs and index fingers (about the size of a quarter). While the subject is using both eyes to look through the circle at the examiner (even from a very short distance of approximately seven feet), the examiner will only see the subject's dominant eye. Dr. Yorks uses this technique on a variety of patients while testing for eye dominance. She is extremely successful with its' accuracy.

Handedness

"The demonstration of superiority of one hand over the other in a physical skill," is Durost's definition of 'handedness' (Durost, 1934). Overall, it is reported that approximately 90% of the American population is right hand dominant (Begley, 1982; Lewin, 1986; Wiley, 1982). Gesell discovered that up to approximately age four, children typically alternate between dominant hands (Gesell & Ames, 1947). These children will even experiment with both hands to complete one task. In this manner, children will attempt to discover which hand actually does work better. Pressures from parents, teachers and siblings for example, may influence the training of one hand to become the dominant hand.

Laterality may even depend on the time in history and the country of your birth. Apparently, a huge round of support encouraged ambidexterity in England just after the turn of the century. Lord Baden-Powell was an advocate for ambidexterity while helping establish the Boy Scouts. He is credited with encouraging this cultural change by setting up the Boy Scout hand shake, left-handed (Harris, 1980).

As people grow older more situations are recognized for choosing to work with the right hand or the left hand. Degrees of individual handedness are the easiest to determine and observe. As more skills and tests are performed and observed using one hand over the other, that individual's hand

laterality is determined. How adept a person is traditionally depends on the task to be completed. Most carpenters, for example, are required to perform tasks equally well using either hand. There are situations almost daily restricting the choice of which hand to use while hammering. A carpenter's job performance relies on the ability to use tools with accuracy as well as strength.

As a young person acquires individual experiences in his/her home environment and school placement, he/she will achieve some degree of success and failure. As he/she continues through this process at an individual rate, their degree of laterality will be practiced and established. There are very few people that are totally right-handed or totally left-handed (Beaton, 1985; Eyre, 1938).

Annett (1970, 1976) devised a peg-moving task that was based upon the time it took to move a series of pegs from one row into another row. Annett discovered as children matured with age, they naturally became quicker. While performing the peg-moving task, the difference in completion time between the dominant hand time and the non-dominant hand remained constant. Indifferent to which hand was dominant, the non-dominant hand always remained the same relative speed behind the dominant one. This constant was established while testing the age ranges of children four through fifteen.

However, through a variety of test evaluations, it should

be noted that regimented practice of any skill would provide an added advantage to the preferred hand.

Sometimes it is easy to forget that a single hand is composed of five different digits and that the relationship between fingers may be both simple and complex. This relationship of coordination and strength usually affects the individual's laterality. Although an individual may prefer using the right hand, it is not always a sign that all hand skills are performed best in this one hand. Parlow (1978) and Kimura and Vanderwold (1970) discovered while examining right-handers, "flexion of an individual's digits was carried out more effectively by the fingers of the left hand." (Beaton, 1985)

Hildreth (1949) discussed the theory that dominant handedness originates in dominant eyedness, and that eyedness is an index of native handedness.

Footedness

Footedness refers to the preferred foot for such tasks as kicking a ball, grasping a small object with toes or stomping on a small item (Springer & Deutsch, 1985). Some researchers identified the use of a shovel (which foot guided the shovel into the ground), the initial step onto a stool, or even which shoe people preferred to put on first as the dominant foot (Gardner, 1941). While the largest muscles of the human body are in the leg, the lateralization of the leg and foot are vital to

gross motor development. One of the more valid tests for footedness has proven to be the initial step onto a small platform (stool) from a standing position (Eyre, 1938).

Porac and Coren (1979) compared other laterality differences with degrees of footedness and handedness. After testing over 5,000 subjects, it was discovered 46% were strongly right-footed. Considering the other possible laterality catagories, almost half is a substantial amount. Slightly more than half of the 5,000 subjects were placed into; 'mildly right-footed', 'neutral' (they did not tend to lead with either foot), or the subjects tended to lead with the left-foot to some degree .

History of Research

From the time people lived in caves, mankind has struggled for three basic needs. Food, shelter and clothes were the prerequisites of survival. Only after solving these problems did mankind flourish. The ability for the human body to obtain laterality may have started as early as the cave man. Calvin (Wiley, 1982), an assistant professor at the University of Washington, provided one explanation of how cave people learning to throw objects made it possible to colonize colder climates. Calvin suggests that learning to throw with one hand produced the very first lateralization. Language skills would eventually be lateralized too, but not necessarily first.

Sequencing is the key to lateralization according to Calvin. As man evolved, the need for food to feed children and to stay warm forced man to begin throwing rocks and sticks. As their throwing ability improved, man began to evolve with increased language utterances and possibly for the first time in history, man's brain began to develop with both hemispheres.

Calvin suggests that this lateralization is not random. He believes that as mothers breast-fed infants, the need to throw rocks and fend off a predator was omnipresent. Mothers typically chose to hold the baby in the left arm and throw with the right. It should be noted that although the heart itself is fairly within the midline of the body, the loud left ventricle of the heart is not toward the midline of the body. That's why the mere sound of the heart may have been a beginning reason for lateralization as well as being a soothing sound for the infant.

Mankind naturally evolved through time. For an entire century before true research of studying physical lateralization related to brain dominance started, scientists believed the left side of the brain was clearly dominant in all normal people. People with damage to the left side of the brain were far more severely impaired physically than people with damage to the right side of the brain. Therefore, if a person had severely injured the left side of the brain, it was frequently assumed that person could not become a normal functioning, contributing citizen again.

Approximately 1865, French doctor Pierre Paul Broca first proposed the vast majority of right handed people 'speak' with their left hemisphere of the brain. He had proven that the left side of the brain controls the right side of the body. Today this is easily proven through a postmortem examination of the central nervous system. The spinal cord literally crosses at the base of the neck allowing the nerves on one side of the body to be controlled by the opposing hemisphere of the brain (Bower, 1987).

During the 1860's and 1870's Dr. Broca, the French neurologist combined efforts with Dr. Wernicke, a German neurologist. They reported that damage to the left cerebral hemisphere produced severe disorders of language, but that comparable damage to the right hemisphere of the brain had no affect on language (Levy, 1985).

From the early 1900's, different scientific reports began to establish what each side of the brain should control. Patients with right side brain damage had problems drawing, using colored blocks to copy designs, reading maps and basic discrimination difficulties. These disorders were much more obvious than with patients who had left side brain damage. The diagnosis at the time, was that the left side was specialized for language and learning processes. In the early 1960's the popular scientific opinion was that people generally thought with only half of their brain. This was contradicted

with a very profound discovery.

Spery revealed that both hemispheres operate independently of each other. As a researcher, he flashed an image of a dollar sign ($) to the left hemisphere of a subjects brain and simultaneously flashed a question mark (?) to the right hemisphere. When asked to respond to what he saw, the patient would physically draw the question mark and verbally responded they only saw 'a dollar sign' (Finn, 1983).

The fact now generally accepted is the left hemisphere of the brain specializes in language for more than 95% of all right handed people and about 66% of all left handed people (Finn, 1983).

Neurological

Degrees of laterality could be measured in a student's hand, eye or foot, depending on the individual preference within any given situation. It is commonly accepted the brain controls the functions of the body, therefore it is a logical conclusion that the brain controls laterality.

There are a variety of possible reasons why a child prefers the left eye for looking at a telescope, the right hand for drawing the stars in the sky and from a standing position he will always walk first by leading with the left foot. In such a situation, he would be functioning cross dominantly. The brain is using both sides of the body during one complex

task. When questioned about this, the student responds by informing the examiner he always looks through the telescope with his left eye because he believes he can draw best with his right hand. The subject adds that he always leads a walk with his left foot because this right shoe never seems to fit properly and the shoe hurts his foot. Or, he could have been sitting in the car on his right leg (to sit higher on the seat and therefore see more out of the window) and his right leg is presently 'asleep.' Or, he was so sleepy on the ride to the planetarium, he fell awkwardly against the car door frame and has a minor subdermal bruise near his eye. Or, during the first trimester of pregnancy his mother accepted a huge holiday cocktail and the few isolated neurological cells affecting the nerve of the right eye never developed. Or, his grandmother currently lives near a poorly managed radioactive waste dump and every visit to Grandma prevents the student from developing fully.

The neurological development begins in people during the first trimester of prenatal birth and continues until the child is approximately six and one-half years old (Hajus, 1971). There are many, many possible reasons why people do not develop the same way, or at the same speed. As children, these same environmental/physiological situations could explain why children switch lateralization from side to side.

Physical lateralization may help influence behavior by

altering the makeup of circuitry in the brain, according to Psychologist Vann Smith (Science News, 1982). Vann Smith also emphasizes that the development of the brain is an important aspect of how an individual could perceive his/her own environment. An individual's perceptions will probably also influence likes and dislikes.

One of the strongest supporters emphasizing the correlation between reading disability and laterality is Dearborn (1929). Among his clinical cases he found a greater incidence of left dominance, crossed dominance, and lack of dominance than among good readers. He suggests that reading difficulties are most likely to appear among children who have been changed over in handedness, or whose physical lateral dominance has never been well-established. Dearborn also suggests to avoid reading difficulties, the reader should be either left-eyed and left-handed; or right-eyed and right-handed. This simply states the readers should be unilateral for optimum success.

Delacato (1963) indicated that complete cerebral hemispheric dominance with the eye, hand and foot all on the same side of the body would be defined as 'neurological organization.' If you are organized, information may be found quickly and utilized with confidence for perpetual growth. It may be assumed, according to Delacato's theory that unilateral dominance is an indication of the presence of neurological

unity, and that crossed dominance or mixed dominance indicates neurological disorganization. With the lack of established neurological organization, it is possible to conclude that there is a slightly elevated occurrence of left-handedness or mixed handedness among delayed/disabled readers than in the general population.

Neuropsychologist Van Lancker maintains that to understand both the grammatical and nonverbal components of language, the two sides of the brain must work together (Bower, 1987). The grammatical portion of language is the printed word and the spoken syntax of language while the nonverbal is illustrated through visual cues. Body language, hand gestures and various forms of unorganized sign language are represented nonverbally. How well both sides of the brain work together, and how well any of the communication processes function, is obviously a key toward that person's success.

Considering the numerous variables within the issues and the amount of available data, this researcher wholeheartedly concurs with the authors Springer and Deutsch (1985, p. 142), "It is likely that no single model of handedness will ultimately explain all the data and that many, if not all, of the theories we have considered will be shown to be true to some extent."

Education

A study by Flick (1966) reported on the hand-eye dominance in physical development compared to perceptual motor tasks in more than 450 four year old African Americans. Cross dominant subjects (mixed left hand-right eye) provided the worst academic performance scores of all the subjects tested. Each child performed significantly worse when compared to other peers (Fink, 1966). That is the tip of the iceberg.

Behan (Geschwind & Behan, 1982) clearly demonstrated an unexpected link between left handedness and other physical attributes. In the two separate studies, a total of 500 strongly left-handed, and 900 strongly right-handed subjects were compared. The strong sinistrals (left-handed subjects) had a rate of two and a half times more physical immunological disorders than that of dextrals (right-handed people). In the field of education, sinistrals also had ten times more learning disorders.

In the daily routine, it is an advantage and promotes better coordination to have the dominant eye and the dominant hand on the same side of the body (citation). As children play and develop physically, they will first gain success with their peers at play, then they will hopefully carry over that established positive attitude into the beginning of their academic training. Various textbook authors bring out a point

that should be noted: it is possible that reading and the ability to read may also affect lateralization (Beaton, 1985; Bryden, 1982; Springer & Deutsch, 1985). Anything children do that is praised and successful, will be repeated. Good readers will naturally spend more time reading than poor readers. The time spent with a book will also have an affect on the development of lateralization. On the same note, children practicing sports would affect and change their lateralization through physical practice. Very early experiences with playing sports, soccer for example, could encourage the player to develope 'no dominance' in his/her feet.

Each student beginning in the early elementary school should have many of the fundamental requirements completed before he/she walks into the classroom. Hopefully the child has had not only breakfast the first school day, but has been given well balanced meals every day. The daily surroundings of the developing student, including the neurological influences (provided through heredity, environmental conditions of fetus nutrition or infant exposure regarding cerebral development), are some of the vital tangibles toward academic success. These are also contributing factors toward developing lateralization (both physical and neurological).

Identifying possible learning problems and getting assistance to the neediest students at this early stage of beginning elementary school, could be the difference between

success throughout the student's basic education or years of academic frustration.

As the child becomes more accustomed to accepting the role of a student, the ability to participate early in classroom activities will be one of the keys to successful, continual learning. In terms of reading and language preparation, Bond and Tinker (1967, p. 117) may have put it best:

> Learning to read is a complicated and, more often than not, an arduous task. For success, the child must be alert, attentive, and able to concentrate and participate vigorously in the classroom reading activities. Any physical condition which lowers a child's vitality so that he is in a continuous state of chronic fatigue makes it impossible for him to give sustained attention to the task at hand. Malnutrition and loss of sleep are examples. The child who is in a state of chronic fatigue may become almost continuously, or at least intermittently, inattentive. When this happens, the child fails to learn what he should or learns slowly. In particular, he fails to learn words or techniques which are necessary for progress in later lessons. These effects are cumulative so that eventually he becomes a disabled reader. In addition, such a child is disposed to develop nervous tensions and a negative attitude toward reading.

In today's society there are ways that classroom teachers may assist their needy students. As informal classroom observations suggest the need for help, elementary school teachers are constantly informally diagnosing students

who may not be sleeping enough, need basic encouragement and support, are not eating nutritious foods, and most of all, students who sincerely try to recall information from one day to the next, but just cannot.

One of the major aspects of students' academic success may be attributed to success in their own individual neurological system. Human nervous systems begin to develop during the first trimester of pregnancy (Delacato, 1963). As the fetus develops both the body and the brain, behavioral patterns emerge. Using sonograms, psychologists in Ireland revealed that 94.6 percent of the fetuses preferred sucking their right thumb (Hepper, 1990). Neurological pathways continue to develop and become more intricate well past the child's sixth birthday. That could help explain how the five percent of naturally left-handed fetuses previously mentioned, increases to the approximately ten percent of adults who are left-handed.

One reason teachers may see students not getting the information presented as quickly as other students, is a possible neurological dysfunction. Delacato (1963) hypothesized that low learning achievement may be due to a lack of neurological organization in the cortex of the brain. The brain is the control center for the entire body. How the brain functions and exchanges messages to muscles while recording information for future use, illustrates the

importance of getting off to a positive start (both physically and academically). Delacato (1963) indicated that complete cerebral hemispheric dominance with the eye, hand and foot, all on the same side of the body would be defined as 'neurological organization.' More often than not, students who are neurologically organized will find information quickly. Therefore, it may be assumed, according to Delacato's theory (1963), that unilateral dominance is an indication of the presence of neurological unity. This implies 'crossed' or 'mixed' dominance indicates neurological disorganization.

In the daily routine, it's an educational advantage to have the dominant eye and the dominant hand on the same side of the body (Dearborn, 1929). Although a direct relationship between reading ability and a student's lack of age appropriate motor control has not been clearly established, Gesell and Amatruda (1941) suggest that muscular incoordination and speech (reading disabilities as a whole), may be attributed to slight brain injuries during birth.

Clearly, muscles on one side of the body are controlled by the opposite side of the brain. The left side of the body is typically controlled by the right hemisphere of the brain. The important aspect concerning how the brain operates (as a general principle), is the depth of the cerebellum. The brain controls the thought process, stores memories, forms associations for learning, and many other extremely intricate

bodiy functions. The cerebral cortex is one of the great wonders of human physiology. These functions do not follow the general rule; one side of the brain basically guiding the opposing side of the body.

It has been established in the field of neurological research that generally the left side of the brain controls the right side of the body. The opposite is true for the right side of the brain being in control of the left side of the body. As with almost any rule of science, there are exceptions.

Interestingly enough, 95% of the right-handed subjects had language stored in the left hemisphere of the brain and 66% of the subjects who are strong left-handers also had language controlled in the left side of the brain (Finn, 1983).

Hildreth (1964) discussed the theory that dominant handedness originates in dominant eyedness, and that eye preference is an index of the original hand (the hand any individual child will prefer to use most often). It is theorized that the difference between eyedness and handedness in later years is due to social and environmental pressures that may influence the training of the right hand into become the dominant hand.

Geschwind proposed "a new view of how a different wiring of the brain's two hemispheres might be related not only to left handedness and learning disorders but also to an altered wiring of the human immune system." (Durden-Smith &

DeSimone, 1984, p. 53)

Using a questionnaire, Geschwind discovered that of the 500 people diagnosed as strong left handed and 900 people strong right handed, the self-proclaimed left-handers had about ten times the rate of learning disabilities.

Both the grammatical and nonverbal components of language and reading are represented by both sides of the brain. As sections of these grammatical and nonverbal components are disected, they are overwhelmingly controlled by either one side of the brain or the other. The language process itself is mentally controlled by the left hemisphere in the majority of people. However, not many people can isolate language with soung or without visual cues. To make matters more complex, not only are both reading and language represented from both hemispheres of the brain, but they are represented at different levels depending on the complexity of the information. The two sides of the brain must work together, almost holistically, to give the student the best chance for academic success.

How the brain functions is still somewhat of a mystery in many fields of science. To some degree, the development of neurological pathways and the choice of physical dominance in children are believed to be connected. One of the questions psychologists and neurologists have spent the last few hundred years slowly uncovering is to what extent and approximately

when, is the most crucial part of any individual physical dominance determined.

Summary

From the beginning as people lived in caves, through studies of babies unborn, researchers have assembled an abundance of research on the lateralization of the body and the neurology of the brain. Although the newest research uses much more sophisticated equipment, it has only begun to show what prior studies could have only dreamed.

Almost every study has either been 'inconclusive' in its summary, or one study could be totally opposed by another study. Usually these contradictions happen when two researchers totally disagree and hope the scientific world evaluates the evidence presented, and will take sides. Nothing has been settled, other than more research is needed. One drawback to having so many studies be 'inconclusive' is several of the studies are utilizing a small handful of extraordinary subjects in the data gathering. Researchers should be reminded that a subject being tested may be on the extreme 'edge' of an issue, and the general population probably will not have the same relative needs. Some studies and the information they uncover simply may not apply to the general public.

The beginning of lateralization may have started with the cave man, but it certainly had an impact as doctors diagnosed brain injuries in the mid 1800's. Left hemisphere brain damage was thought to be permanently disabling. Subjects acquiring any left hemisphere brain damage were usually dealt with by simply separating them from society.

At the time, neurology and physiology was in its infancy. Few doctors knew the left side of the brain controls spoken language, and it controls the entire right side of the body. Not too long ago, for a person to be even slightly damaged on the left side of the brain, the diagnosis and treatment would probably be devastating.

In these modern times, many physicians and medical specialists would admit the left side of the brain does foster language (as it is heard and spoken), while the right side of the brain encourages and helps retain written information and spatial-visual experiences. How the two sides of the brain work together is the key toward success in both school and the amount of 'relearning' any individual must do.

The earlier students get the appropriate individual attention, if they have an educational deficit; the better for the student. They will be more successful at an early age and hopefully continue that success throughout their educational program. One way to ensure an early success is try and provide beginning elementary students with a safe, well rounded

foundation both physically and neurologically. The body should be as prepared as well the mind. How the physiology of the body and the brain affects success is something of which every parent and educator should be aware.

Chapter III

The Research Design

Purpose

The purpose of this study was to discover if second grade students having a unilateral dominance will be academically higher in reading than their bilaterally dominant, or mixed laterally dominant classroom peers.

Null Hypotheses

H_o^1

There will be no statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the bilateral dominant group on a standardized reading achievement test.

H_o^2

There will be no statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the mixed dominant group on a standardized reading achievement test.

Methodology

Subjects

The 85 subjects for this study were age-appropriate second grade students attending a variety of Western New York elementary schools. The classes and schools were randomly selected. To participate in this study, each of the students must have taken a standardized reading test in his/her home school. The standardized reading tests were administered by familiar, on-campus staff.

Instruments and Procedures

As a group in the classroom, the subjects were given a brief explanation of the lateral dominance testing process. The laterality tests and observations were conducted individually outside of the classroom. This was done in the hopes of reducing the students' anxiety. The testing materials were handmade and centered around the theme of testing individual lateral preference for the hand, eye and foot.

The classroom instructor reminded the students that they would be tested individually and please not to discuss with the other students what the physical tasks entailed. The tasks were designed to identify which eye, hand and foot any individual would prefer to use. The first task asked the subjects to write their name on a self-stick removable note

pad. This is the first indication of hand preference. The subjects were then instructed to manually pick up a variety of objects from a container placed directly in front of them. The objects included coins, red or green dice, and three different colored plastic golf balls.

As one final task to determine hand laterality, the subjects were instructed to choose one of three toy kaleidoscopes. This enabled the researcher to identify students having mixed laterality. Any student who picked up the kaleidoscope in one hand and used the opposing eye for sight, could be labeled as having mixed laterality.

To help determine foot laterality, the students chose one of two sponge balls. They were instructed to set the ball on the floor and stomp on it. The foot choice for stomping indicated foot laterality. A second foot laterality task had the students stepping onto a short stool. The initial raised foot was observed and recorded as the dominant foot (Eyre, 1938).

The students then were instructed to put both hands down toward his/her side and point to a one inch dot. The dot was pre-placed on the wall directly in front of the stepping stool. The initial hand was again noted as the dominant hand. The students were asked to point to the dot again using the non-dominant hand. The combined pointing action would verify the dominant eye. Only one hand should cross the midline of the body; the dominant eye should be revealed (Springer & Deutsch, 1985).

For the last eye preference task, the students mimicked a hand formation provided by the researcher. While placing both index fingers together and slightly overlapping one hand on top of the other (extend both thumbs) a small half-dollar sized hole could be made. The subjects were told to extend the arms straight out and look through the 'hole' made by the hand shape. As the subject looked through the hole at the researcher, the researcher could only see the dominant eye.

The students were thanked for their help and permitted to leave the stepping stool platform. The initial foot while exiting was designated as the dominant foot (Eyre, 1938).

Analysis

The students' physical lateral dominance preferences were recorded by this researcher and used for the data tables included in the appendices. Every student's lateral preference was categorized according to his/her individual results.

Unilateral dominant students would have a clear majority of the tasks performed using only one side of the body. Of the six tasks presented, unilateral students would use the same side of the body in eight, or all nine of the subskills.

Bilateral students were classified as using one side of the body for any one set of tasks and then switching to use the

entire opposite side of the body for a separate group of tasks.

Mixed lateral students used a crossing pattern for either side of the body for all of the six tasks. They would have no clear dominant side for any one task. In addition, they would have no clear majority for a preference on the entire dominance test.

After recording the individual students' reading percentile scores on the Stanford Achievement Test (Form J, Level P2), a comparison was made to their lateral preference tests.

The t-test for independent measures was used to find statistical differences between the mean raw scores of the unilateral and bilateral second grade students. A second t-test was used to find statistical differences between the mean raw scores of the unilateral and mixed lateral second grade students. A t-test value of +/- 2.00 declares a significant difference between the two variables, and would suggest additional statistical analysis.

Chapter IV

Analysis of Data

Purpose

The purpose of this study was to discover if second grade students having a unilateral dominance will be academically higher in reading than their bilaterally dominant, or mixed laterally dominant classroom peers.

Research Questions

The following research questions were investigated:

1. Will there be a statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the bilateral dominant group on a standardized reading achievement test?

2. Will there be a statistically significant difference between the mean scores of the unilateral dominant group and the mean score of the mixed dominant group on a standardized reading achievement test?

Laterality Identification

Of the 85 age-appropriate second graders tested, 47 were males and 38 were females. Testing this many subjects on three physical categories provides a great deal of cross referencing in regard to physical comparisons.

Thirty-seven students were classified as unilateral, (completing eight or all nine laterality tasks with the same side of the body). Within the unilateral group, all 37 of the students were right-side unilateral and zero students were left-side unilateral.

Twelve second graders were bilateral. They identified one body part as totally dominant over the mate, while body parts crossed the body's midline; left-eye, right-hand, right-foot and so forth.

Almost equal to the unilateral amount, 36 students demonstrated overall mixed lateral dominance. Mixed dominant subjects had no clear dominance in the laterality tasks and therefore frequently crossing the body midline.

Research Results

While preparing to receive standardized reading scores, 126 students in two school districts were tested for individual laterality. As the two school districts used different reading tests, only 85 second graders from one school were used for

comparing reading ability and individual laterality.

The first research question compares the mean reading scores of the unilateral and the bilateral second graders. Overall the 37 diagnosed unilateral students achieved a mean reading score of 54.35. The bilateral students surpassed that amount by 9.40 points, but there were only 12 students labeled bilateral. The group of bilateral students achieved a mean of approximately 56.87. The unilateral standard deviation about the mean was 16.06 while the bilateral standard deviation about the mean was 10.02.

The t-test for independent measures was used to find statistical differences between the mean raw scores of the unilateral and bilateral second grade students. A t-test value of +/- 2.00 declares a significant difference between the two variables, and would suggest additional statistical analysis. In this study, the mean for the unilateral group was not significantly higher than the bilateral group. The obtained t-test value was -1.9. This indicates that the difference in mean raw scores (9.40), is a typical difference that should occur in 95 out of 100 repetitions of this experiment.

These data revealed that the unilateral students did not score significantly higher on the test of reading achievement than did the bilateral students (See table 1).

Table 1

The t-test difference between the mean raw scores of the Unilateral and Bilateral student groups.

	df	mean	s.d.	t-obtained
Unilateral	36	54.35	16.06	
Bilateral	11	63.75	10.02	- 01.90

t-critical = +/- 2.00; $p < .05$

df = degrees of freedom
mean = mean average of the students' standardized reading raw scores
s.d. = standard deviation about the mean

The second research question compares the mean reading scores of the unilateral group and the mixed laterally dominant students. While not repeating the unilateral scores, the number of students, mean and standard deviation (for each group) were very much the same. The unilateral group of 37 students had a mean of 54.35, and the standard deviation about the mean was 16.06. The mixed lateral group consisted of 36 students, a mean of 56.81 and a standard deviation about the mean of 18.73.

The t-test for independent measures was used to find statistical differences between the mean raw scores of the unilateral and mixed lateral second grade students. A t-test value of +/- 2.00 declares a significant difference between the two variables, and would suggest additional statistical analysis. In this study, the mean for the unilateral group was not significantly higher than the mixed lateral group. The obtained t-test value for these variables was -0.60. This indicates that the difference in mean raw scores (2.46), is a typical difference that should occur in 95 out of 100 repetitions of this experiment.

These data revealed that the unilateral students did not score significantly higher on the test of reading achievement than did the mixed lateral students (See table 2).

Table 2

The t-test difference between the mean raw scores of the Unilateral and Mixed lateral student groups.

	df	mean	s.d.	t-obtained
Unilateral	36	54.35	16.06	
Mixed lateral	33	56.81	18.73	- 0.60

t-critical = +/- 2.00; p< .05

df = degrees of freedom
mean = mean average of the students' standardized reading raw scores
s.d. = standard deviation about the mean

Post-Hoc Laterality Analysis

Adding the other school (containing 41 second grade students), a much larger subject pool may be discussed in terms of the statistical results of laterality. Unfortunately, the reading results of both schools' standardized tests were not compatible and can not be compared. However, the laterality alone for this larger group is worth examining.

Overall, the laterality groups were expected to have an approximate equal number of students in each group. The results show there are even numbers in the unilateral and mixed classifications, but not nearly as many students were in the bilateral group.

Analysis of Total Laterality Data

Of the 126 students, 90% (or 113 subjects) could be predicted to be predominantly right-handed and the remaining 10% should be left-handed (13 subjects). It is interesting to note that 75 students were totally right-handed (60%) for all three hand dominance tasks, while an additional 42 students (117 students in all, or almost 92%) were right handed while writing their names. Two students (approximately 1.5%) were totally left-handed, however nine students wrote their names left-handed (7%). (Appendix A, Handedness Graph)

Crossed hand to eye dominance occurred when a student

chose the kaleidoscope with one hand and then crossed the physical midline to view the picture using with the opposing eye. If a subject initially began viewing the kaleidoscope in this situation and made himself/herself more 'comfortable' by switching either the hand or the eye, the laterality data were recorded while he/she was describing the kaleidoscope picture. Ninety-four students did not cross the midline of the body. Thirty-two second graders either crossed the midline or were undecided. As in the case of seven students, while they examined the picture, the tube was established near the bridge of the nose.

The 'dot pointing' technique contained some potential ambiguity because the students were evaluated subjectively. As students were pointing at the dot and near the midline, the task was repeated in a similar manner for verification. Between the 'optometrist circle' and the 'pointing' tasks for testing eye dominance, 98 students demonstrated the same dominant eye for each task (78%). Three-fourths of the subjects tested were predicted to be right-eye dominant (41% actually were). Seven students were ambiguous while they pointed near the body's midline or established the 'circle' at the bridge of their nose. These students were labeled as 'mixed' eye dominant.

According to the 'Eyedness Graph' (Appendix B), nine students wore glasses and the simple majority of those nine (seven students wearing glasses) were mixed lateral. As all 50

of the overall unilateral students were right-sided, there were no left-eye unilateral subjects. All 21 of the left-eye dominant students fell into the bilateral category. Adding the seven undecided eye-dominant students, with the 21 who had obvious 'different' eye dominant traits for both tasks, over 22% of the students tested had no established eye dominance.

A previous physical dominance report had 46% of the subjects tested as 'strongly' right-footed. All other categories combined (moderate or slightly right-footed, neither foot as dominant, or any combination of left-footed as dominant) represented only 54 percent. Actual testing proved that 66 second graders (approximately 52%) were 'totally' right-foot dominant. By a majority of approximately 2:1, the right-foot dominant students were also unilateral. Only 12 students chose to stomp on the sponge ball with the left foot (9.5%). Three students (2%) were 'totally' left-footed for all three foot oriented tasks. (Appendix C, Footedness Graph)

In addition to the evaluation of overall physical laterality, the correlations of one body part to another were analyzed. Eye to Hand One task was specifically designed to isolate the eye-hand relationship. For example, if the kaleidoscope crossed from the right hand with the left eye, that would illustrate crossed dominance between body parts. In this case, the hand and the eye crossed the midline for 32 second graders (approximately 25%). Interestingly, right-handed to left-eyed

students (22 in all) outnumbered the left-handed to right-eyed students (10) by more than double.

The remaining three-fourths of the students were observed as being unilateral for the hand-eye task. The other eye to hand task was observed during the 'pointing' task for eye dominance. It was noted that although the subjects were given a choice of initially raising either hand for pointing at the eye level dot, 92% of the students pointed using the right hand first. This clearly agrees with the 89% previously mentioned students who wrote their name right-handed.

Hand to Foot Using the statistic of penmanship compared to the stomping of a sponge ball, almost identical numbers were observed. One hundred sixteen were right-handed when they wrote their names and 114 subjects stomped on the sponge ball with their right-foot. Using these two isolated tasks, a 98% agreement was achieved.

Eye to Foot Numerically speaking, right-eye dominant students numbered 52, left-eyed were 39 and mixed (undecided) eye dominant students totalled 35.

The footedness results do not illustrate the same type of balance. While 66 students stepped onto the stool, stomped on the sponge ball and exited from the testing area using the right foot initially, three subjects completed the same tasks with only the left foot. The remaining 57 second graders used both feet in a mixed fashion.

The closest correlation with the eye and foot may be made while comparing the right eye and the right foot. From the 126 second graders, there is a 79% correlation that the right-eye and the right-foot would both utilized. There is less than an eight percent chance (three left-foot dominant and 39 left-eye dominant students) of having the left-eye and the left-foot be used by the same student. This supports the results of finding no unilateral left-sided students (considering all three physical dominant body parts).

Of the 70 males participating in the laterality testing, 27 were unilateral, 11 were bilateral and 32 were mixed lateral. Of the 56 females tested in the laterality testing, 23 were unilateral, 12 were bilateral, and 21 were mixed lateral.

Summary

The statistical analysis shows there is no statistically significant difference between the second grade students' unilaterality or bilaterality, and their performance on a standardized reading test.

The statistical analysis shows there is no statistically significant difference between the second grade students' unilaterality or mixed laterality, and their performance on a standardized reading test.

This study attempted to discover if second graders observed as being unilateral were better readers (on a standardized reading

test) than bilateral or mixed lateral peers. The unilateral students clearly did not surpass either the bilateral or mixed lateral group.

Chapter V

Conclusions and Implications

Purpose

The purpose of this study was to discover if second grade students having a unilateral dominance will be academically higher in reading than their bilaterally dominant, or mixed laterally dominant classroom peers.

Conclusions

The statistical results of this study indicate there was no statistically significant difference between the different types of laterality and standardized reading raw scores of second graders.

A t-test for independent measures was used to analyze the unilateral and bilateral raw scores on the Stanford Achievement Test (total reading subtest). It was found there was no statistically significant difference between the two laterality groups.

A second t-test for independent measures was used to analyze the unilateral and mixed lateral raw scores on the Stanford Achievement Test (total reading subtest). It was discovered there was no statistically significant difference between these two laterality groups.

Data worth noting include the mean reading scores of the

separate lateral groups. The unilateral group (37 students), obtained a mean reading raw score of 54. The bilateral group (12 students) averaged a reading raw score of almost 64, and the mixed lateral group (36 students) averaged a reading raw score of 36. It appears that students who have established educational neurological pathways from both sides of the brain may score a little bit higher on some tests. Also the unilateral and mixed groups were fairly equal in all portions of the raw score reading results. However the lowest scoring bilateral student, was above 23 other unilateral and mixed lateral students.

Research Implications

The results of this study showed the laterality of any one of the tested second grade students did not differentiate from his/her reading ability. This research was possibly conducted too late in the students' physical and neurological development to show the intended significance.

Additional research is suggested through possibly testing students at an earlier age. Additional comparisons of other groups of second grade students may shed light on how (or when) some reading skills are obtained and enhanced. Assembling a much larger group of students may also be considered.

Using the same pool of subjects for a longitudinal study may prove beneficial. In a longitudinal study, a follow-up

comparison of how the same students have physically grown while examining academic growth may be beneficial to both parents and educators.

Future researchers may consider administering a series of laterality tasks at either the end of the first grade (before the end of school begins to distract classroom behavior), or after the students have settled into the second grade (early October). In either situation, a well timed and appropriate academic achievement measure should accompany the laterality tasks. This type of comparison (laterality and academic progress) may assist in identifying a student who may not yet be ready for certain academic skills.

Classroom Implications

Educators today are faced with a huge responsibility of not only teaching academics, but of fostering emotional stability and physical growth as well. Identifying students who may need additional support early (in a vast variety of areas), could be the difference between a career of rewarding successes in school or a long term struggle to simply tolerate the academic system while 'getting-by'.

The laterality tasks described and used in this study were presented to students in a formal testing atmosphere. As a classroom teacher, the availability to observe students on a daily basis may provide the same types of information. A student in

the second grade who has inconsistent academic performances may simply be subconsciously trying to find a better solution. Or the same student may have a serious health concern requiring attention.

Summary

This study attempted to discover if second graders observed as being unilateral were better readers (on a standardized reading test) than bilateral or mixed lateral peers. The unilateral students clearly did not surpass either bilateral or mixed laterality group.

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Appendix A

Handedness Graph

	Right Dom.	Left Dom.	Mixed Dom.	Pen Held	Kal. 'X'
Unilateral	46	0	4	Rt. 79 Lt. 01	No 47 Yes 3
Bilateral	15	2	6	Rt. 06 Lt. 02	No 9 Yes 14
Mixed Lateral	14	0	39	Rt. 32 Lt. 06	No 38 Yes 15
TOTAL	75	2	49	Rt. 117 Lt. 9	No 94 Yes 32

TOTAL STUDENTS 126

Right Dom. (Right Hand Dominant)
all three tasks were completed using the right hand only

Left Dom. (Left Hand Dominant)
all three tasks were completed using the left hand only

Mixed Dom. (Mixed Handed)
the three tasks were completed using either hand in any combination

Pen Held - illustrates which hand was used for writing his/her name

Kal. 'X' - illustrates if the hand crossed the physical midline while picking up and looking through the kaleidoscope)
example: No - the midline was not crossed = right hand - right eye
Yes - the midline was crossed = right hand - left eye

other abbreviations: Rt. (right) Lt. (left)

Overall student laterality has been catagorized through the nine laterality tasks.
Unilateral - completed eight or all nine of the tasks from one side of the body
Bilateral - switched sides of the body between different tasks
Mixed lateral - no preference within the tasks while using both sides of the body

Appendix B

Eyedness Graph

	Rt. Eye	Lt. Eye	Mix Eyed	Gls.	'O' / Pts.	Kal. 'X'
Unilateral	42	00	8	2	Same 42 Diff. 08	No 47 Yes 03
Bilateral	01	21	1	0	Same 23 Diff. 00	No 09 Yes 14
Mixed Lateral	09	18	26	7	Same 33 Diff. 20	No 38 Yes 15
TOTAL	52	39	35	9	Same 98 Diff. 28	No 94 Yes 32

TOTAL STUDENTS 126 (LATERALITY - ONLY)

Rt. Eye (Right Eye) - all three tasks completed using only the right eye

Lt. Eye (Left Eye) - all three tasks completed using only the left eye

Mixed Eye - any combination using either, or both eyes while testing

Gls. (Glasses) - the number of students observed wearing glasses

'O' / Pts. - describes and compares the results of the 'optomistrist circle' and the pointing/midline technique; if the student used the same dominant eye for both tasks

Kal. 'X' (illustrates if the hand crossed the physical midline while picking up and looking through the kaleidoscope)

example: No - the midline was not crossed = right hand - right eye
Yes - the midline was crossed = right hand - left eye

other abbreviations: Diff. (Different)

Overall student laterality has been catagorized through the nine laterality tasks.

Unilateral - completed eight or all nine of the tasks from one side of the body
Bilateral - switched sides of the body between different tasks
Mixed lateral - no preference within the tasks while using both sides of the body

Appendix C

Footedness Graph

	Right Foot	Left Foot	Mixed Foot	Stomp
Unilateral	38	0	12	Rt. 50 Lt. 00
Bilateral	13	1	9	Rt. 20 Lt. 03
Mixed Lateral	15	2	36	Rt. 44 Lt. 09
TOTAL	66	3	57	

TOTAL STUDENTS 126 (LATERALITY - ONLY)

Right Foot - all three tasks were completed using only the right foot

Left Foot - all three tasks were completed using only the left foot

Mixed Foot - any combination using either, or both feet for the tasks

Stomp - the foot choice while stomping on a sponge ball

Overall student laterality has been catagorized through the nine laterality tasks.

Unilateral - completed eight or all nine of the tasks from one side of the body

Bilateral - switched sides of the body between different tasks

Mixed lateral - no preference within the tasks while using both sides of the body