2002

The differences in performance of a left vs. right brained golfer on a curvilinear golf course

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THE DIFFERENCES IN PERFORMANCE OF
A LEFT VS RIGHT BRAINED
GOLFER ON A CURVILINEAR GOLF COURSE.

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Landscape Architecture

in

The School of Landscape Architecture

by
Robin S. Jamison
B.A., University of Mississippi, December 1999
August 2002

DEDICATION

To the next chapter…

ACKNOWLEDGEMENTS

I would like to thank my committee members, Joseph Popadic, Dorothy Jenkins, and Dr. Melinda Solmon, for spending time helping and guiding me throughout this entire process. I would also like to thank Louisiana State University Golf Course, especially Mike Johnson, for allowing me to use their golf course for the purpose of this study.

I will forever be indebt to my parents and brother for their support and never ending love. I could not have had any better role models than my father, mother, and brother. I hope that I can be as impressive on others lives as they have been on mine. Love and thank you to Dad and Mom, Billy, Nicole, and Josephine Jamison, Robbie, Sheila, Chris, Kim, and Britton Robertson, Terry, Jennifer, and Elizabeth Denny.

I would also like to thank my classmates for making my two and a half years at Louisiana State University enjoyable. A special thank you to my boyfriend, Jason R. Watton, for your support and for being a part of my life.

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ABSTRACT

Our everyday movement is reflected by those individuals who design the world in which we live. Ninety percent of the people who shape our everyday lives are right handed. Individuals perceive life differently, especially left and right handed individuals. One reason left and right-handed individuals interpret differently is due to the brains' two hemispheres processing information separately. Can this difference in interpretation result in varying abilities of performance?

Research has proven that those individuals who are right hemisphere dominant process and comprehend shapes better than left hemisphere dominant individuals. Golf is an activity that is exhibits the constant changing of visual shapes. With this knowledge, the derived conclusion would imply that the right hemisphere dominant individuals should interpret the curvilinear shapes presented on a golf course better than the left hemispheric dominant individual. This thesis tests for the differing abilities in performance between the left and right hemispheres on two curvilinear holes.

CHAPTER 1 INTRODUCTION

Which is better, to be left handed or right handed? For most people the answer is very simple. Right handed is better, easier, and more convenient. Now, which is better, to be left brained or right brained? This is where the answer gets a little more difficult to answer. Typically if you are right handed you are left brained while the opposite is true of the left hand. While this is not always true, there are tests that contain a set of questions that are used to determine hemispheric dominance, for now we will assume the hemispheric dominance reflects hand preference.

What about the small percentage of those who are left handed? The world has been programmed for the right-handed person while the left-handed person has been an afterthought (Figure 1.1 and 1.2). With a few exceptions, the same is typically true for athletics. There is proof that left-handers do have an advantage in some sports including boxing, baseball, and tennis. Some sports, such as field hockey, allow practically no room for a left-handed player (Brown, 1979; Coren, 1990; Coren, 1993; Fincher, 1977). A sport that can allow for many left handed players, but displays few, is golf. Pertaining to handedness, this is a sport that is very under-researched and until recently has had very few left-handed

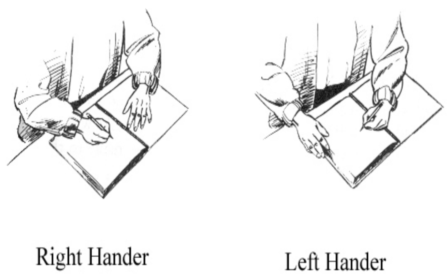


Figure 1.1: Displays the Differences in Writing

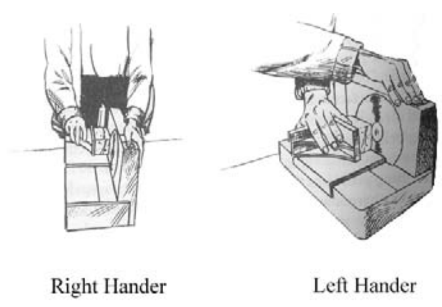


Figure 1.2: Displays the Differences in Work

Source: Coren, 1993

participants is golf. The men's PGA (Professional Golfer's Association) Tour has only seven golfers that play left-handed. None of the left-handed golfers have ever won a major championship. Arnold Palmer and Ben Hogen, still considered two of the most impressive golfers in history, are both left handed but play golf right-handed. This thesis explores the relationships between the brain and the golfer.

1.1 Problem Statement

Objects and activities have been designed for the right-handed individual due to their ninety percent dominance in society. This overpowering bias has appeared to pressure a right-handed dominance onto the golf course as well. As Jack Fincher stated in his book Sinister People (Fincher, 1977):

> To kicking and throwing from the left, I early on added tennis and, much later, bowling. Thanks to a hand-me-down set of clubs-whose heads, like most of those throughout Western history, were dead set against my maverick predilection- I learned to golf, if wretchedly, from the right. After a successful stint of switch-hitting in softball, I decided I should bat right (like a lot of ostracized left-handers, as it happens) which may explain why I never again hit as much as my weight. (Fincher, 1977 pp. 20-21)

The assumption underlying the study is that since most golf courses are created for the right-handed golfer, they hinder the left-handed golfer's performance on most golf courses. The objective of this study is to examine whether the there is a difference between the performance of left and right-brained golfers on curvilinear golf courses. If in fact the research indicates a difference towards the either golfer, the secondary objective is to evaluate from this information gathered whether or not a golf course design could be formulated to favor a certain hemispherically dominant golfer. This information could also facilitate the creation of a golf course equally challenging for both of the dominant hemisphere and handedness.

1.2 Scope

The scope of this thesis is to explore whether there is a correlation between the curvilinear design of golf holes and the typical hemispheric brain characteristics. The study will examine golfers performance on two holes that have a significant bend in the fairway, that are commonly called dogleg holes. A definition of a dogleg is an obvious bend, right or left, on a golf hole with the inside angle never to be less than 90 degrees (Figure 1.3)(Cornish and Graves, 1998). One hole will be a dogleg left and the second hole will be a dogleg right. Because many golfers have some of the same problems, such as the typical right-handed golfers slice and the typical left handed golfers hook therefore, the two opposite dogleg holes were chosen. This is to help provide a more equal opportunity for each of the golfers advantages or disadvantages to balance out.

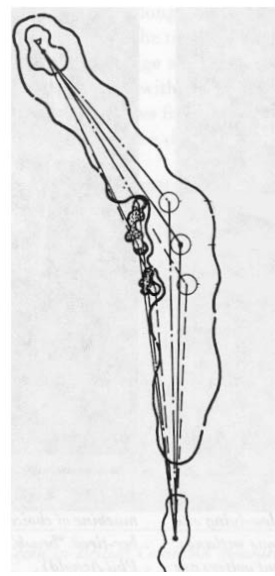


Figure 1.3: Typical Dogleg Hole

Source: Hurdzan, 1996

1.3 Literature Review

1.3.1 The Other Half

The human brain is a paired organ that is basically split into two halves (Figure 1.4). Each side of the brain, typically called *hemispheres*, is almost a mirror image of the other. The term *brain lateralization* is used because, although the hemispheres look similar, their performance and abilities are very different. In humans, the most obvious difference is portrayed in speech, language, and spatial

abilities (Deutsch & Springer, 1993). In the 1972, Robert Ornstein published the first book on the functions of the left and right brain hemispheres. About that time, other neurologist and psychoneurologists began their own investigations. Many of these professionals had been evaluating patients with brain damage, when they noticed impairments in mental and physical functioning occurring on the side opposite of the brain damage (Ornstein, 1997; Iaccino, 1993; Bradshaw, 1989; Beaton, 1986; Fadely & Hosler, 1983; Brown, 1979; Fincher, 1977). Researchers began investigating the brain's hemispheres in hopes of better understanding the correlation between the brain and various problems, such as epilepsy and other cerebral dysfunctions. While investigating the hemispheres, some characteristics of the brains processing functions were discovered. Identification of the hemispheric functions controlling language and speech was credited to the left-brain, while the right brain was credited with spatial, sensory, and motor skills. Not until the 1980's did the laboratories of neurologists and psychoneurologists begin to provide public information regarding the theory behind the differing functions of the left and right hemispheres (Fadely & Hosler, 1983).

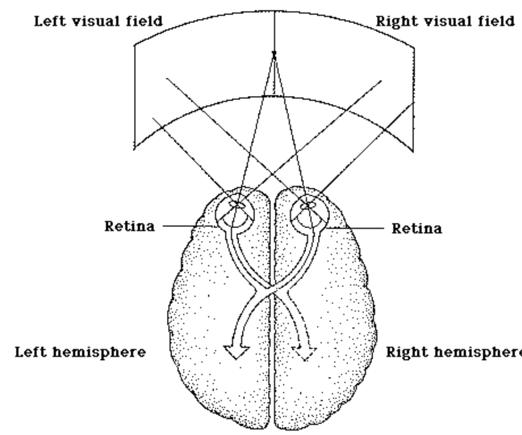


Figure 1.4: Brain Hemispheres
Source: Deutsch & Springer, 1993

Though some controversies still exist about precise functions of the brain, many of the original theories of overall functionality are now considered standard. Roger Sperry won the Nobel Prize in Physiology in 1981 for his work and discovery of the split-brain functions. Sperry's research was with patients who had surgical

division of the brain, therefore dividing the mind into two distinct realms of consciousness. While his research indicated that each half of the brain is capable of perceiving, learning, remembering, and feeling independently of each other, he also acknowledges that there are differences in the way each hemisphere deals with processing incoming information (Ornstein, 1997; Deutsch & Springer 1993). The functions are typically described as the left-brain primarily controlling the language/speech and auditory aspects while the right brain is specialized to process spatial information. In the book, *Case Studies in Left and Right Hemispheric Functioning*(Fadely and Hosler, 1983), the hemispheric functions are broken down into hemispheres (Figure 1.5). The left hemisphere specializes in the control of speech, synthesis of verbal-auditory data, logical and rational behavior, higher

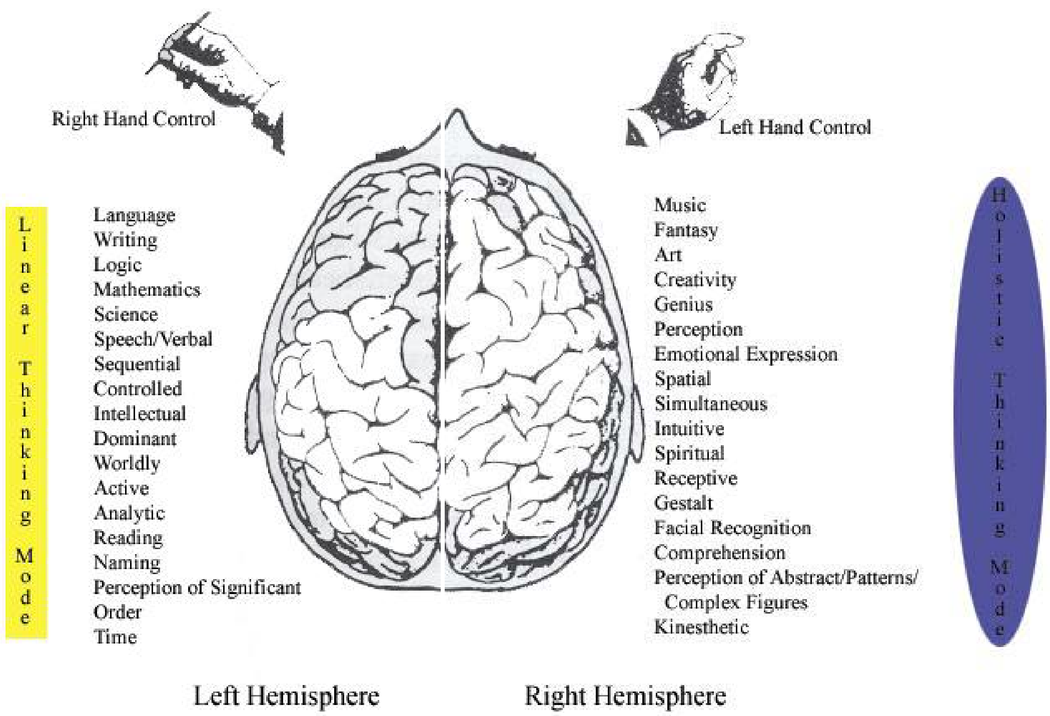


Figure 1.5: The Hemispheres and Specific Functions

Source: Coren, 1993

mathematical skills, and the perception of time and sequence of events. The right hemisphere specializes in nonverbal auditory information, recognition and manipulation of form and shapes, recognition of form space relationships, understanding the behaviors of objects and people, perception of perceptual gestalt, execution of complex gross and fine motor movements, and computation of simple math (Ornstein, 1997; Coren, 1993; Hellige, 1993; Iaccino, 1993; Coren, 1990; Deutsch & Springer, 1993; Bradshaw, 1989; Fadely & Hosler, 1983; Brown, 1979; Corter, Segalowitz, Trehub & Young, 1983; Brown, 1979; Fincher, 1977; Hecaen, 1964).

From the beginning of life, our brain hemispheres develop at different speeds. When we are infants, our right brain is developing faster, taking in the visual surroundings and sounds. The right hemisphere, especially the frontal area, is maturing much faster and its functions develop in concert with what is happening in the baby's world at the time. The known functions of the right hemisphere and its earlier development enable the baby to respond to spatial clues, such as finding the moving mother while also controlling large limb movement. The Sylvian fissure (Figure 1.6) is the area of the brain located in the left hemisphere that is most involved with the development of language and speech. During this time when the right hemisphere is maturing, there is a delay in the left

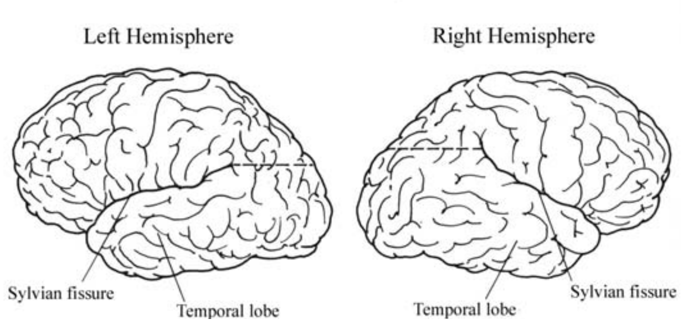


Figure 1.6: Hemispheres' Sylvian Fissures
Source: Deutsch & Springer, 1993

hemisphere's development near the Sylvian fissure. During the third to sixth year of a child's life the left hemisphere continues to grow and develop more rapidly than the corresponding areas of the right hemisphere (Ornstein, 1997).

Many researchers, doctors, and psychologist believe that information describing the functions of the left and right hemispheres is very important. Joseph Bogen, a neurosurgeon, believes that this information has serious implications for education. He argues that the current emphasis on verbal skills and the development of analytic thought process, typically a left-brain function, results in neglecting of the development of important nonverbal skills. He claims that by emphasizing only one hemisphere, we are in fact "starving" the other half ignoring its potential contribution to the development of the entire person (Deutsch & Springer, 1993). Another set of researchers believe that by accepting the hemispheric dominance of an individual, the use of combined theories could aid in an easier educational process. They presume "different hemispheric styles will require different modes of information processing" (Fadely & Hosler, 1983, p. 62).

1.3.2 Hands and the Brain

The dominant hand is a marker for brain lateralization, i.e. left-handed individual would be right hemispherically dominant, as a right-handed individual would be left hemispherically dominant (Figure 1.7). Handedness is a term often used to describe the hand, left or right, that one prefers on a regular basis (Coren, 1993). Recent concern has been placed on the relationship between the brains' hemispheric functioning and peoples handedness. Studies have shown that there are differences in the way people who are left-handed and right-handed process and

organize information. Right-handers have shown through testing that they process vocabulary much better than left-handers. Results from research that was performed on a group of college individuals testing their intellectual and academic skills, helped emphasize how accurate the hemispheric functions are as the right handed students regularly scored higher than the left handed students. Other research tested students' ability to visualize and identify an object by mentally manipulating an image of an object to its mirror image. Typically the left-handed participants were able to correctly identify the object while the right-handed participants were not (Coren, 1993). This research supports the theories about split-brain functions and is directly related to the individuals' handedness.

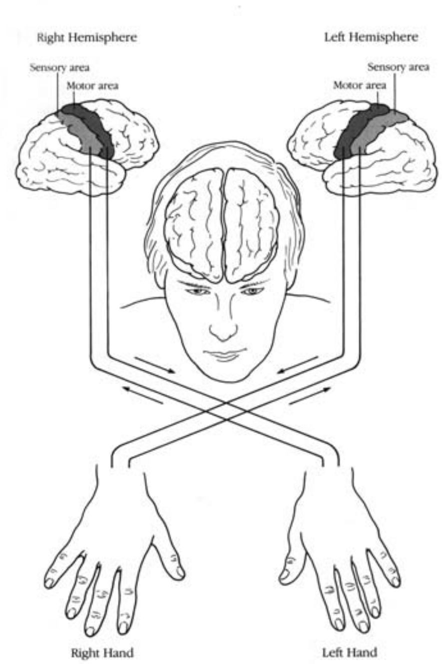


Figure 1.7: Hands and Brain Association

Source: Deutsch & Springer, 1993

Many disabilities often tend to be associated with the left handed/right brained individual. Left handed individuals have a higher risk of being dyslexic, mentally handicapped, epileptic, alcoholic, schizophrenic, or depressive, along with other disorders (Ornstein, 1997; Coren, 1993; Deutsch & Springer, 1993; Hellige, 1993; Iaccino, 1993; Coren, 1990; Bradshaw, 1989; Beaton, 1986; Fadely & Hosler, 1983; Corter, Segalowitz, Trehub & Young, 1983; Brown, 1979; Fincher, 1977; Hecaen, 1964). For example, left-handers are 12 times more likely of having dyslexia

whereas; only 1 percent of those who were right hand dominant were reported having learning disabilities (Coren, 1993).

There is also evidence that left-handers often tend to be more extreme in their overall abilities. The concept of "feast and famine" has been proposed to describe the left-hander (Coren, 1993). The "famine" side of the left-hander has already been discussed in the high numbers of individuals having various disabilities. The "feast" aspect is that, in certain groups of extremely bright individuals, there are unexpectedly high numbers of left-handers. Camilla Benbow, a psychologist who is interested in the "feast and famine" idea, studied the top 10,000 students who took the Scholastic Aptitude Test. Benbow and associates gathered the scores along with the handedness of the 10,000 students and found that the brightest individuals are more than twice as likely to be left-handed. "The implication is that left-handers are apt to be extremely dull or extremely bright" (Coren, 1993, p. 177).

Researchers have begun examining the family history of left-handed individuals. A difference is present between left-handed persons who come from a left-hand dominant family and those that come from a right-hand dominant family. The left-hander belonging to a left-hand dominant background is more likely to have speech and visual abilities in both hemispheres while lacking the verbal abilities in the left hemisphere. The left-hander belonging to a right-hand dominant background is more likely to have verbal abilities in the left hemisphere (Coren, 1993; Coren, 1990; Beaton, 1986; Fadely & Hosler, 1983; Brown, 1979; Hecaen, 1964).

Because only 10 percent of the population is left-hand dominant, there is no doubt that we live in a right-handed world (Figure 1.8). Robert Ornstein's research indicates that of the 10 percent left-hand dominant population, only 66 percent are totally right hemispheric dominant (Figure 1.9). Of the 90 percent right hand dominant population, 90 percent are totally left hemispheric dominant (Figure 1.10). From his studies, he also discovered that the left hand dominant population is more hemispherically versatile than the right hand dominant population (Ornstein, 1997).

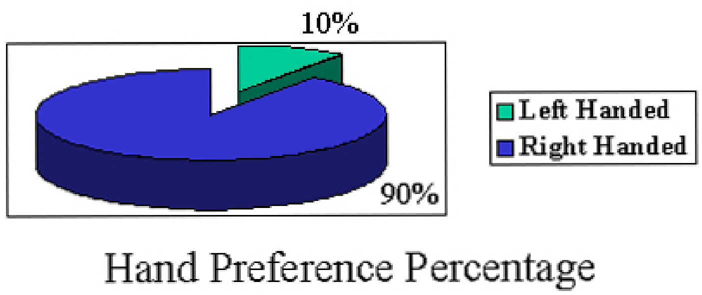


Figure 1.8: Population Hand Preference Percentage

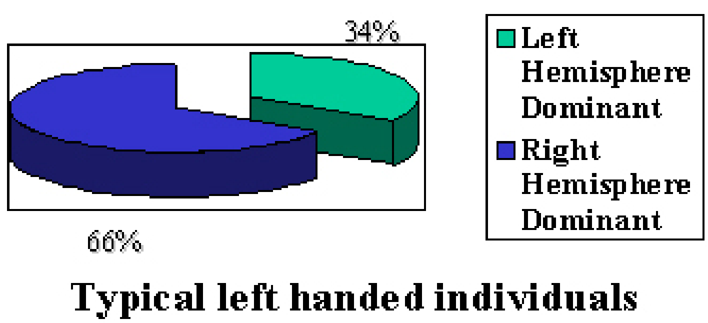


Figure 1.9: Left-Hand Hemispheric Dominance Population

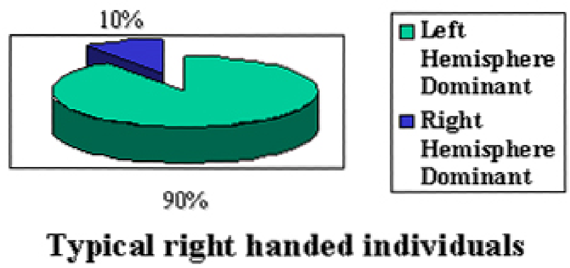


Figure 1.10: Right-Hand Hemispheric Dominance Population

Mark Brown speculates that a left handed person my not find life as easy as a right-handed person, even though many left-handers are found to be more ambidextrous than right-handers. A left-hander can, at times, take advantage of the situation in athletics due to the opponents' unfamiliararity with the handedness (Brown, 1979). Some surprisingly believe that left-handers have an intrinsic advantage over right-handed athletes due to superior spatio-motor skills. This superiority is suggested as a result from the left hemispheres specialization in language, which overshadowed the right hemispheres development of spatio-motor skills. Resulting in an "impairment" which is thought to be a handicap of a variety of components, such as the capacity for visuo-spacial thinking, fine control of both left and right hands, and the ability of faster reflexes for both sides. With the visuo-spacial advantage of a left-handed athlete, some researchers suggest that they may have a higher degree of overall skill in such tasks that require usage of both hands because of the bilateral representation of axial motor control (Aggleton, 1989).

1.3.3 Spatial Ability of Games

Many games require good spatial skills, but one most often associated with the relationship between left-handedness and spatial ability is chess. The game of chess requires one to recognize patterns and geometrical shapes. There is some

evidence that in general in the game of chess as well as among chess masters, there is an excess of left-handers. To play and be successful in the game of chess, one must have the ability to recognize changing patterns and shapes. This overabundance of left-handers, once again provides evidence that the dominance of the left and right hemispheres role correlated with dominant handedness (Coren, 1993; Beaton, 1986; Brown, 1979).

Robert Trent Jones Jr., a golf course architect and golfer, compares a golf course to the game of chess. He writes that the ever-changing obstacles as an individual is moving down a golf hole and the continuous changing of shapes is very similar to chess' changing spatial characteristics. The trees heights and placement are moving in and out along the holes, while the fairways too are typically shaped by the ever-changing curvilinear pattern of cut grass which is moving in and out along the hole. Jones (Jones, 1993) writes that in order for a golfer to perform successfully he must keep a quickly moving mindset to accurately analyze the features of the course (Figure 1.11).

Figure 1.11: Shapely Golf Hole

Common golf hole with continuous changing visual stimuli.
Source: Jones, 1993

Dr. Michael J. Hurdzan (1996) writes about his ideas of golf courses spatial features in his book Golf Course Architecture:

> Once any golfer reaches the first tee, he or she begins to read the specific architectural language of symbols provided by the golf architect. It may begin as a subconscious awareness of space in the driving area as defined by trees, traps, mounds, lakes, or tall vegetation. From these elements one senses a pattern of risks and rewards and a flow of positive and negative forces offering alternatives of danger and security. Often a visual rhythm of repeated patterns is identified, inviting further inspection. (Hurdzan, 1996 p. 148)

He also conveys the message of an architects goal of creating out of scale features on the golf course to give the player "subtle surprises" and illusions of deception, which challenges each individual's mind (Hurdzan, 1996).

Many golfers understand the feeling of illusion and inaccurate depth perception, which a good golf course provides. Tom Watson, a long time member of the PGA Tour and friend to Robert Trent Jones Jr., recollects the aspects of the golf course that provided him with feelings of spatial illusion: the grass types, planting and design of a golf course. Robert Trent Jones Jr. (1993) describes a golf course like a painting. He believes that an architect should paint a golf course like Picasso, allowing the range of colors, bunker types, and other "features" to create illusions for the golfer. A runway tee, a long thin teeing area, is described as creating another amazing visual effect. The runway tee is typically positioned directly at the preferred landing area, which is also near a hazard or some other spatial obstacle (Jones, 1993).

Other common features helping to create illusions are water and bunkers (Figure 1.12). When approaching water hazards, the golfer is presented with a two-dimensional design, which requires spatial interpretation to accurately assess the situation. Three-dimensional designs are presented when approaching bunkers and

trees. These spatial features can at times, be much harder to interpret because of the distance and height of each object. Jones recalls an incident with a friend as Jones himself inaccurately interpreted a visuo-spatial feature on the golf course during the 1990 U.S. Open:

Figure 1.12: Sand Bunkers

Common addition to a golf hole that helps stimulate visual illusions.
Source: Jones, 1993

> 'Bob, see that bunker on the right side of the fairway—how far is it from the green?' I answered that the distance was about 30 yards. He turned to me astonished and said, 'You've got to be kidding, it's flush against the putting surface, so there's no way it can be more than five yards.' (Jones, 1993 p. 219)

Jones said that his friend was correct in that the spatial illusion created by the bunker had led him to misinterpret the green. As they approached the green, he began explaining the common technique that designers use of changing the topography therefore shaping the ground around visual targets, in order to create this spatial illusion (Jones, 1993).

Dogleg holes are often visually misinterpreted by golfers. Often designers create a spatial distraction by tempting the eye to focus on objects such as bunkers, trees, or water. The designer may purposely place one of these objects in the direct line of site requiring the golfer to evaluate the spatial features that are presented. This illusion can lure the golfer into believing the hole to be shorter and a landing area to be smaller, therefore directing the golfer to target a different and often times, a more hazardous, location (Hurdzan, 1996; Jones, 1993).

1.3.4 Left-Handed Golf

Nine out of ten golfers are right handed (Kraus, 2001). This small percentage has led to a void in the production of information and tools for those left handed golfers. Many famous golfers, such as Ben Hogan, Arnold Palmer, Nick Price, Johnny Miller, and Curtis Strange are left-handed individuals that have become right-handed golfers because of this lack of equipment (Kraus, 2001)(Blauvelt, 2001)(Corbett, 1997).

Phil Mickelson, Mike Weir, Steve Flesch, Greg Chalmers, Russ Cochran, and Kevin Wentworth are the only golfers on the PGA tour who play left-handed. Mickelson has become a poster boy for the left-handed golfer. Those who do play left handed are hoping that the now, seven member lefty group, will inspire young players. As a young child, Weir considered switching to his right-hand and decided to write Jack Nicklaus a letter asking his advise. Nicklaus suggested Weir stay with his natural swing (Blauvelt, 2001).

Mickelson, Hogan, and Palmer are interesting cases in the game of golf. Unlike Hogan and Palmer who are lefties but play right-handed, Mickelson, who is naturally right-handed but plays golf left-handed. His left-handed swing is a product of his fathers teaching. His father would stand across from Mickelson resulting in a mirror image of the golf swing (Blauvelt, 2001). Mickelson has been very successful on the tour, but has not won a major championship. Fables surrounding the ability of the left-handed individual reflects that of public opinion that if and when Mickelson is in the lead for a major tournament, without a doubt the “lefty will eventually make a fatal mistake” (Stricklinb, 2001).

CHAPTER 2 METHODOLOGY

There is almost no research on the differences in performance of the left and right-brained golfer. Although there is plenty of information on the differences between the left and right brain individual, none of it addresses athletic performance. The left and right aspect of athletics especially golf, is still very under researched. This thesis is addresses that need. The study site is the Louisiana State University golf course. The course has both left and right doglegs (Figures 2.1 and 2.2). The

Picture 1: View from tee box to canal

Picture 2: View from the front of canal towards green

Picture 3: View from 150 yard marker, where hole bends, towards the green

Figure 2.1: Louisiana State University Golf Hole #4. Dogleg left

golfers participating in this questionnaire will be only those who volunteer. While golfing is a recreational, it is also a very serious sport. Those who enjoy the game of golf, value the time and peacefulness that the golf course provides. This study was

Picture 1: View from tee box to canal

Picture 2: View from the front of canal towards green

Picture 3: View from 150 yard marker, where hole bends, towards the green

Figure 2.2: Louisiana State University Golf Hole #5. Dogleg right

designed to minimize interference for the golfer while obtaining the most accurate results possible.

In order to identify left and right-brained individuals, experts have compiled a set of questions as to what characteristics classify the brains' hemispheres. The left brained individual controlling dominance in speech, verbal-auditory data, logical and rational thoughts, and behavior. The right brained individual controlling dominance in non-verbal auditory information, recognition and manipulation of form and shapes,

recognition of form space relationships, and kinesthetic abilities (Ornstein, 1997; Coren, 1993; Hellige, 1993; Iaccino, 1993; Coren, 1990; Deutsch & Springer, 1993; Bradshaw, 1989; Fadely & Hosler, 1983; Brown, 1979; Corter, Segalowitz, Trehub & Young, 1983; Brown, 1979; Fincher, 1977; Hecaen, 1964). Several tests typically use the same questions. This survey begins with five questions pertaining to demographics and then proceeds to the brain dominance test which consists of twelve questions taken from two web sites: Left or Right Brain? and Hemispheric Dominance Inventory Test (Intelegen, 2000)(Trampe, 2001). The two web sites have been combined with information from the 4Mat Model (1999) for use in this thesis. The 4Mat Model is a questionnaire that was devised by psychologists for this use of distinguishing hemispheric dominance (Appendix A). Once the volunteer completes the five demographic questions and the twelve hemispheric dominance questions, the golfer will then be asked to fill out the designed survey by marking the approximate landing location of each shot with an "X" (Appendix B). The golfer will also be asked how many strokes it took them to reach the green. Spatial analysis of locations will determine any correlations between the left and right-brained golfer.

The Strokes to reach the green will be analyzed in two ways. Using the Analysis of Variance procedure, simply called "ANOVA" analysis, the number of strokes will match up with a handicap and will be compared against the opposite hemispheric dominant golfer with the same handicap. The ANOVA analysis will use "Repeated Measures ANOVA" to calculate the average mean, standard deviation, minimum score, and maximum score. The matching of the handicap creates a balanced overall ability. The idea of subtracting the handicap from each individual's

score could interrupt the findings because of players putting ability. This thesis is not measuring the golfers spatial adaptation on the green, but is measuring the golfers spatial perception of the entire hole. By only using the strokes until reaching the green, I am better able to analyze the golfers spatial abilities against their hemispheric dominance. The matching of handicaps to hemispheric dominance instead of the average comparison between golfers of different hemispheric dominance is also due to the specific analysis of the spatial perception of the hole and not of the green. While the handicap is measuring the ability of the golfers entire score and not of a certain aspect, it is the most identified control mechanism known to golf.

The scores will be totaled and the average mean will be calculated. For the purpose of this thesis, 0.5 or a half of a stroke will be significant. In golf, one stroke is a tournament winner or looser. The second analysis will be on the location of the golfers ball position. The ball position of each stroke has been documented and from that information, a masterplan with each participant's ball location will be compiled. This compilation, with the help of the statistics department, will be analyzed as to any correlation of the hemispheric performance that is taking place on the golf course. The performance of the left and right-brained golfer as to their personal spatial interpretation of the course will be noted.

This overall analysis of the ball position can interpret a correlation that exists between many people of the same hemispheric dominance. It can educate us on any similarities that exist and help us to identify other possibilities.

CHAPTER 3 THE QUESTIONNAIRE

3.1 Pre-Survey

The initial question of asking the "date" of which the survey was taken is used to clarify the pin placement on the green. Pin placement effects where the golfer aims their shots and can affect their overall score if the pin placement is in a difficult location. During the time of the research, the pin placement was changed on Tuesdays, Thursdays, and Saturdays. This knowledge is needed in order to accurately compare the results from this experiment. The question of "gender" is asked to understand who is being analyzed. This is asked because men are one and a half times more likely to be left-handed than women because of testosterone in the womb mildly slowing the growth of the left hemisphere (Ornstein, 1997; Coren, 1993). Gender information helps in understanding the population of women who play golf and their differences to the men while comparing more accurately testing the population.

Preference of which hand is used in everyday activities is asked to have knowledge of their typical predetermined hemispheric dominance. This also allows me to know whether they do fall into, what researchers, have described as their hemispheric dominance. The following question of whether they play golf left handed or right handed is helpful in understanding that if the individual do not fall into their typical hemispheric dominance, if could have something to do with the reversed hand preference roles during the golfing activity. The book "Drawing on the Right Side of the brain" by Betty Edwards, is an example of the reversed hand preference roles affecting hemispheric dominance during a certain activity. Simple

activities to put your right brain in action, such as covering the right nostril allowing for breathing solely out of your left nostril, is suggested to get a more creative look. If the golfer answers the hand preference questions differently, the question of why is asked.

The question of why the dominant everyday hand compared to the golfing hand is to help us understand whether the acceptance of a left handed golfer is becoming available. In the past, left handed anything was hard to find, but left-handed golf clubs were almost unheard of. Now golf product manufacturers are recognizing that left-handed golfers have had very few options and are trying to bring their equipment up to the same quality as the right-handed golfer. The reason for most individuals playing right handed if they are in fact left-handed is due to force because of the lack in equipment.

The final question before the participant completes the hemispheric dominant designed survey is somewhat crucial to the experiment. As in pin placement, in order to accurately evaluate individuals, the question of handicap is asked. Handicap is a compilation of scores that is used to determine one's ranking among other golfers. Comparing individuals by their handicap helps to create a smaller margin of error in that the golfers experience, weather, and course ambiguity should not affect their score.

3.2 Survey

The twelve-question survey was used to minimize the golfers voluntary time of filling this out. It is also used because it forces the golfers to be either left brained or right brained. To be considered dominant in either hemisphere there must be a

minimum of seven questions answered out of these twelve for a specific side. There is an option of "equally preferred" for those people who are not biased in their actions.

Question number one- When you walk into a theater, classroom, or auditorium (and assuming that there are no other influential factors), which side do you prefer? This is a question of the subconscious. The side that one automatically is drawn to is in theory the dominant side a person prefers for everyday common tasks (Coren, 1993)

Question number two- Do you believe that there is a right and wrong way to do everything? By answering, "yes" to the question, one is associated themselves to the typical left brained thinker. The left brained thinker makes more objective judgments and is more analytical. "No" implies the right-brained individual who prefers more open-ended questions, thoughts, and ideas generally has that ability to talk around questions (4Mat Model, 1999; Coren, 1993; McCarthy, 1980).

Question number three- Do you often have hunches? The right brained person would likely answer, "yes" to this answer. Right brain is more intuitive, following their gut instincts. The left-brained dominant individual prefers more linear thought process and order. The right brain is said to be somewhat chaotic (4Mat Model, 1999; Coren, 1993; McCarthy, 1980).

Question number four- Setting goals for yourself helps keep you from slacking off? If the answer is "yes" it is likely that the individual is left brained. The left mode is responsive to a structured environment. Its' thought processes are in a hierarchical, sequential, and planned structural setting. The right brain dominant

person, views life as more spontaneous, enjoying participative environments (4Mat Model, 1999; McCarthy, 1980).

Question number five- When you are confused you usually go with your gut instinct? Similar to question three, but this is asking whether or not one actually goes with their instincts. The left brained individual makes objective judgments based off of established, more concrete information then solves the problems logically. The right-brained individual is typically going to answer yes to this question. They prefer subjective judgments while solving problems from patterns and configurations (4Mat Model, 1999; McCarthy, 1980).

Question number six- Do you keep a 'to do' list? The need for structure plays a significant role in the left brained individual. For them, the every day activities of what must be done in a certain amount of time is often times written in a verbal instruction list. The left-brain responds to the instruction much better than the right brain because of the reliance on the need for sequence, plan, and structure is dominated by the left-brain. The right brain is fluid and spontaneous while being essentially self-acting. In place of lists, the right brained individual is driven by the images and feeling that present themselves (4Mat Model, 1999; McCarthy, 1980).

Question number seven- Can you tell approximately how much time passed without a watch? The ability of time is very much a left-brained characteristic. Time follows in the left brained theories of structure. The spontaneous and intuitive right brain is not as able to follow time (4Mat Model, 1999; McCarthy, 1980).

Question number eight- Is it easier for you to remember people's names or to remember people's faces? This question pertains directly to the differences between

the two hemispheres. The left-brain is better with languages and verbal skills making them better with names than the right brain. The right brain, which is known for its imagery skills, is much better at recognizing faces (4Mat Model, 1999; Ornstein, 1997; Coren, 1993; Iaccino, 1993; Hellige, 1993; Deutsch & Springer, 1993; McCarthy, 1980).

Question number nine- Would you prefer to express your feelings through drawing or writing? This question takes us back to the simplest left and right hemispheric theories. The right-brained individuals are the drawing hemispheres. They are more able to express their ideas through pictures, manipulating objects, and patterns. The left-brain, which dominates the brain growth for several years when we are children, is the language dominant hemisphere. Much better at understanding concrete facts and written instructions, this hemisphere would rather a word than a picture (4Mat Model, 1999; Ornstein, 1997; Coren, 1993; Iaccino, 1993; Hellige, 1993; Deutsch & Springer, 1993; Coren 1990; Bradshaw, 1989; Beaton, 1986; Fadely & Hosler, 1983; Corter, Segalowitz, Trehub, & Young, 1983; McCarthy, 1980; Brown, 1979; Fincher, 1977; Hecaen, 1964).

Question number ten- Have you considered becoming a poet, a politician, an architect, or a dancer? This question is relating directly to the right brain. If you answer “yes” to any of this question, it is insinuating that you are right brain dominant. All of these professions deal with open-minded problem solving skills, spatial skills, participative skills, multi-variable research, and kinetic stimuli (movement or action). These are the abilities of the right brain (4Mat Model, 1999; Coren, 1993; Iaccino, 1993; McCarthy, 1980).

Question number eleven- When speaking, do you use gestures, that is do you use your hands when you talk? If you were to answer with “many” you are implying that you are a right-brained individual. The movement is related to the kinetic stimuli, body language, and the fluid imagination. The left brained individual, who would answer “few” hand gestures, is displaying the more logical thought that actions do not need to display what my vocabulary can describe (4Mat Model, 1999; Coren, 1993; McCarthy, 1980).

Question number twelve- Do you tend to control your feeling or are you more open with your feelings? This final question is also typical of the left and right hemispheric characteristics. The right brain, which is more emotional and free with feelings will likely answer that they are “open.” The left brained individual will often answer that they “control” their feelings. The left-brain is more rational with their thought, not guided by their emotions as the right brain is (4Mat Model, 1999; Coren, 1993; Iaccino, 1993; Hellige, 1993; Deutsch & Springer, 1993; Coren 1990; Bradshaw, 1989; Beaton, 1986; Fadely & Hosler, 1983; Corter, Segalowitz, Trehub, & Young, 1983; McCarthy, 1980; Brown, 1979; Fincher, 1977; Hecaen, 1964).

While these questions do not cover the entire processes of the brain, it does cover a large portion of what research has proven to be true of the brains’ hemispheres. For this thesis, this questionnaire is the determinate of whether an individual is dominant in either hemisphere. After this information is determined, I will move onto the analysis of the performance on the golf course by these individuals.

3.3 Performance Task

On the back of the survey a drawing of the two dogleg holes chosen are used for the golfer to record their ball position. The two holes are back-to-back, number four and five, were selected for several reasons. They are both dogleg holes that fit the criteria of a dogleg right and a dogleg left. They both had similar qualities of a canal stretched in front of each of the tee boxes and a pond that is located close to the greens. The final reason these two were selected, is because of their placement being located together, the golfers are able to complete this survey in a very short period of time, without severely interrupting their game.

As the golfers play the two holes, they are asked to document where their balls landed each time with an “X” on the drawing. When they finished the hole they are asked where they teed off from, their score, and the number of putts. The number of putts is not needed for analysis only the number of strokes. The number of putts is asked to get an accurate count of how many strokes it took to reach the green. For the purpose of this thesis, the golfers’ score is the number of strokes to reach the green. The overall spatial feature of the golf hole and how the individual performed, is what is being tested.

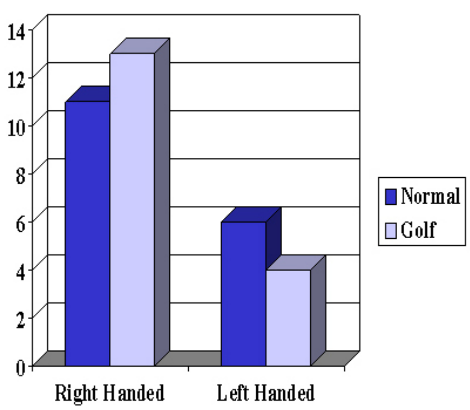
CHAPTER 4 ANALYSIS

4.1 Testing

The research that was performed for this thesis is to be analyzed several ways. The information was observed through a statistical program called Statistical Analysis System (SAS) Statistical program to calculate mean averages, standard deviations, mean differences, and Time Effect relationships. Repeated measures analyses of variance (ANOVAs) were performed to test for group differences and interactions between the left and right-brained individuals' scores on the two holes. ANOVA was also used to analyze statistical differences between the left and right-brained golfers' ball placement.

4.2 Subjects

A group of thirty-four subjects had matching credentials and were used in this research. The seventeen left-brained golfers had a matching right-brained golfer with the same handicap, with the same green pin placement, and used the same tee box. Of the thirty-four individuals, the handicap ranged from zero to twenty-eight. This research covered a wide range of abilities on the golf course. It also contained a variety of hand preference, hemispheric dominance deviation. Of the seventeen right hemispheric dominant individuals, eleven



Right Hemisphere Dominant

Figure 4.1: Right Hemisphere Dominant Group

Normal every-day and golf hand preference

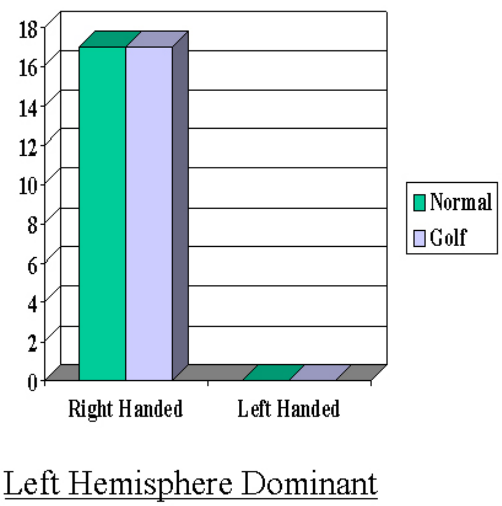


Figure 4.2: Left Hemisphere Dominant Group

Normal every-day and golf hand preference

were right hand dominant and six were left hand dominant (Figure 4.1). Of the seventeen left hemispheric dominant individuals, all seventeen were right handed (Figure 4.2). Fifteen individuals did not completely fill out the survey or did not have a proper match to be included in the study. All, but one, were left hemispheric dominant and right hand dominant. Eleven individuals tested to be equally hemispheric dominant.

4.3 Results

The means and standard deviations were calculated upon the initial analysis of performance between the two hemispheres for each of the holes and are presented in Table 4.1.

Table 4.1: Mean and Standard Deviations for the two holes.

	4th Hole		5th Hole	
	Mean	SD	Mean	SD
Left-Brained	2.94	.90	2.82	.88
Right-Brained	2.94	.75	2.64	.61
Grand Mean	2.94	.81	2.74	.75

The repeated measures ANOVA used to test group differences and interactions for the number of strokes to reach the green revealed no statistically significant effects. Right-brained and left-brained golfers scores did not differ on the

fourth hole [$\underline{F}(1, 32) = 0.00$, $\underline{p} > 1.00$] or the fifth hole [$\underline{F}(1,32) = 0.46$, $\underline{p} > .50$], and the hole by group interaction was also not significant [$\underline{F}(1,32) = 0.33$, $\underline{p} > .56$]. This indicates that the scores on these holes did not vary according to the hemispheric group. It must be noted, however, that there are a low number of subjects in the study, given the conditions dictated by the nature of the data collection. An increase in the number of subjects would have resulted in a more powerful study, and the .18 stroke difference that was evident could have been statistically significant in a more

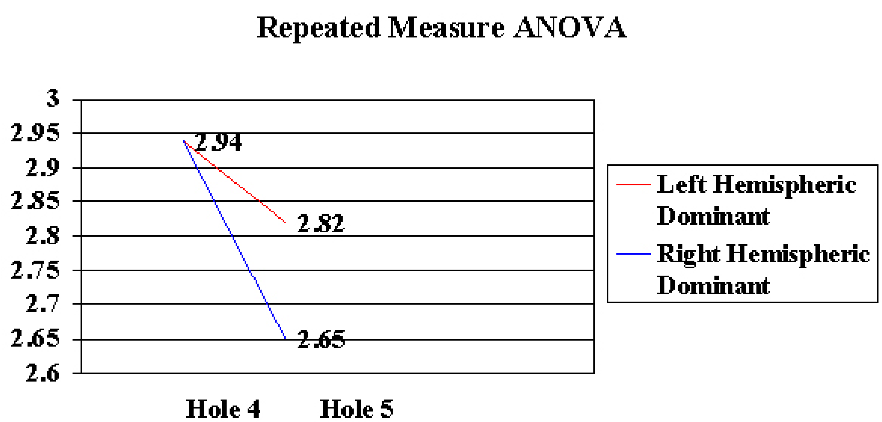


Figure 4.3: Repeated ANOVA Test Results from hole #4 and hole #5.

powerful design (Figure 4.3).

The spatial analysis to assess group differences in shot placement was performed using two repeated measures ANOVAs. Because every volunteer had at least two strokes to reach the green, the spatial statistics for only the first two strokes were analyzed. All thirty-four individuals had at least two strokes and played the two holes, which resulted in a hundred and thirty six-line analysis. The X and Y coordinates for the shot placement were transformed in generate a single variable representing ball location. A 2 (hemisphere group) X 2 (4^{th} hole and 5^{th} hole)

ANOVA with repeated measures on the second factor was conducted for shot one and for shot two. No significant effects were evident on the first shot or second shot for hemisphere group or hole, and the group X hole interaction was also not significant. The means and standard deviations for the ball placement variables are presented in Table 4.2.

Table 4.2: Means and standard deviations (in parentheses) for shot placement

	4th Hole		5th Hole	
	Shot 1 Mean (SD)	Shot 2 Mean (SD)	Shot 1 Mean (SD)	Shot 2 Mean (SD)
Left-Brained	33998.85 (38735.13)	44782.14 (133087.83)	63784.03 (141643.46)	93655.30 (222972.53)
Right-Brained	31670.09 (33446.50)	40970.26 (68501.16)	42892.97 (61444.58)	17533.20 (21376.64)
Grand Mean	32834.47 (35654.64)	42876.20 (104243.30)	53338.5 (108029.54)	55594.25 (160683.51)

Finally, to more closely investigate group differences between hemispheres, four t-tests were conducted, one for each of the four shots. Of the four comparisons, only the ball placements on the second shot of the fifth hole approached significant (t (32) = 1.40 $p > .17$). Although this does not represent a significant group difference, in consideration of the low power associated with the study, it does appear that the study suggests that the right hemisphere group was more accurate in the placement of their second shot on the fifth hole could be evident (Figure 4.4 and 4.5).

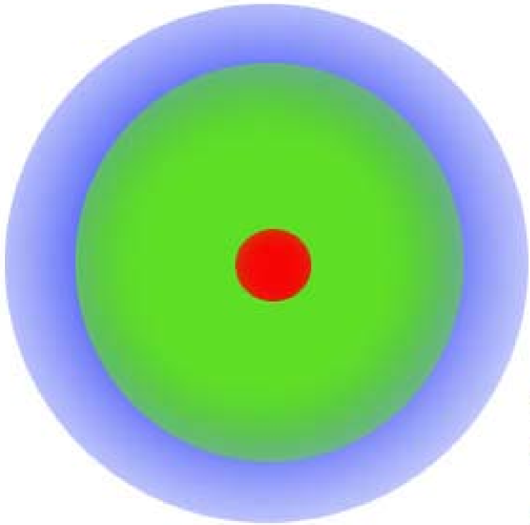


Figure 4.4:

Typical Ball Placement In Study

- Target
- Right Hemisphere Ball
- Left Hemisphere Ball

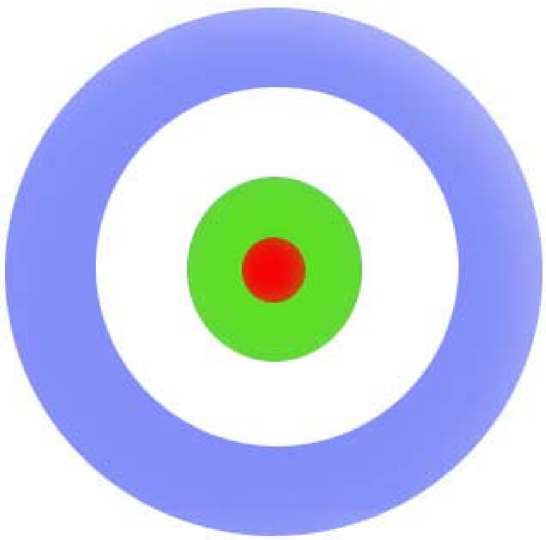


Figure 4.5:

Ball Placement for 2nd Shot 5th Hole

- Target
- Right Hemisphere Ball
- Left Hemisphere Ball

4.4 Observation

The final analysis is an assessment of the hemispheres' ball placement for the drive on both of the holes. After plotting each individual's ball position on a map, a grouping analysis will determine any correlation between the hemispheres.

On the fourth hole, seventy percent of the right hemisphere dominant golfers had a first stroke ball location right of the target. While on that same hole, the left hemisphere dominant golfers ball location was not as localized. The left hemisphere had sixty five percent of the golfers located left of the target with five

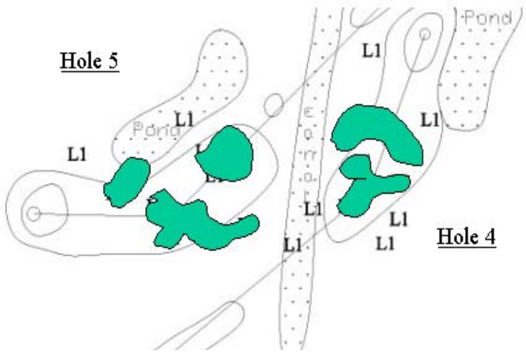


Figure 4.6: Left Hemisphere Shot 1

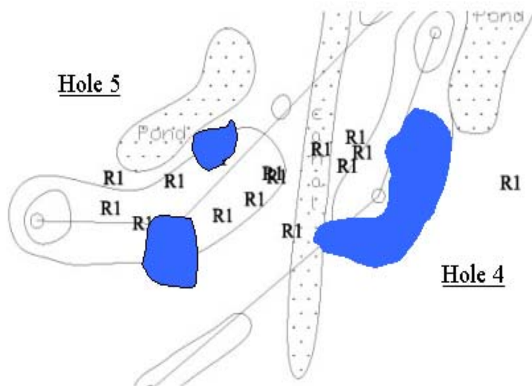


Figure 4.7: Right Hemisphere Shot 1

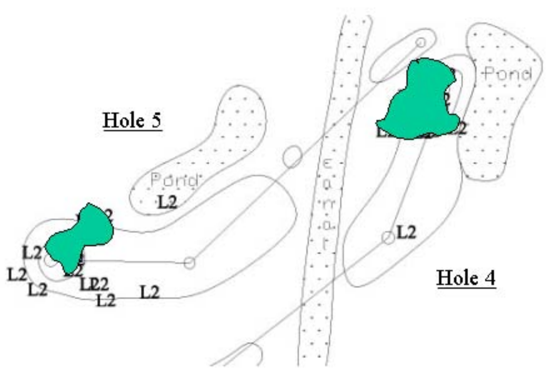
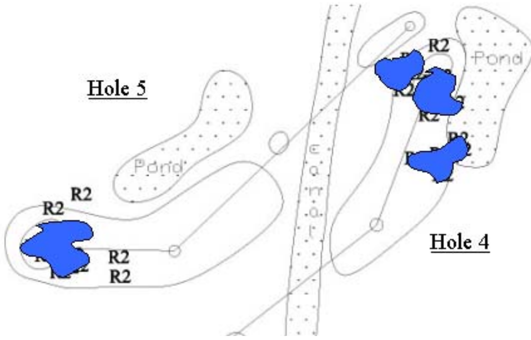


Figure 4.8: Left Hemisphere Shot 2

golfers were localized on the center suggested target (Figure 4.6). The fifth hole first shot displayed the right hemisphere as being sporadic with a small grouping of five located slightly left of the target (Figure 4.7). On that same hole, the left hemisphere has three groupings; one located on and left of the suggested target. The second group is located in the front right corner of the fairway and the final group is located several yards past the suggested target on the far right. The pattern indicates that the left hemisphere is more consistent in the common ball placement among those tested. While the right hemisphere is not as consistent with ball locations spread further apart than those of the left hemisphere.



The second shot grouping analysis indicates only a pattern noteworthy on the fifth hole. The right hemisphere is much more localized than the left hemisphere (Figure 4.8 and 4.9).

Figure 4.9: Right Hemisphere Shot 2

CHAPTER 5 CONCLUSIONS

Then intent of this investigation was to examine the influence of hemispheric condition on golf performance. This information is valuable because if this is an important factor in golf, there could be significant implications concerning the design of golf courses. First of all, could a designer now alter a golf courses' layout to be more suitable for most any golfer? Secondly, should designers have the opportunity to recognize and appreciate the differences in individuals while enabling a more challenging golf game? For example, a golf course architect could now design a golf course that would be more suitable for the right-brained golfer and how they think. The layout, while still being challenging to the any golfer, would now invite those who are typically left handed/right brained golfers to play the dominant role on the course. Habitually the golf course is designed for the right-handed golfer, which is the most common golfer, while being uninviting to the left handed/right brained golfer.

To recognize that there is a difference between the brain's performances could create a greater interest in everyday design. Those who naturally prefer to be left-handed but train to be right handed could have one fewer obstacle to overcome. Many golfers who are left handed, play right-handed. The reason for switching of hands was indicated by the participants of this study to be caused by the lack of equipment when learning to play this game. This research could also provide a more psychologically friendly society and more open for brain performance adversity.

The findings from this study did indicate some difference on one hole. The study suggested a slight difference between the hemispheres, in favor of the right

brain. This correlates with the theories surrounding the right hemispheres superior ability of perception. While the research did only find a slight difference on one hole, the difference could create a disturbance in score if there were eight other holes like it. If a course were to have nine holes similar the hole tested and displayed the slight variance in left and right hemispheric dominant individuals, the difference of 0.2 strokes could possibly become a difference of 1.8 strokes. That is a very large difference in the game of golf. I believe that if the larger population was tested, it would not only increase the power of the study, it would also indicate a greater difference in performance between the left and right hemispheres abilities.

The results of this study did indicate the possibility of a difference in performance. This creates a topic that has been undiscovered thus far in golf course architecture as well as other athletic fields.

5.1 Recommendations

If the subject of golf were tested again, I would hope for several things. First, the population needs to be much larger. By increasing the population size, it will make the study much more powerful and allow for validity to this research. Secondly, be able to acquire a stronger testing agent to decipher the left and

Figure 5.1: Shadows on the Course

The simple illusions that vegetation can create on a course would help with visual stimuli. Source: Jones, 1993

right hemispheres of the participants. An accredited testing agent that is recognized by psychologists will strengthen the study in several ways. It will be more widely recognized by psychologists, which will create a stronger acceptance in the athletic community as well. Lastly, to find a golf course with more defined curvilinear dogleg holes (Figure 5.1-5.3). In figure 5.1, the shadows that are created by the late afternoon sun, also enhance the features on the golf course. Many features add to what each individual perceives when viewing from a distance on the golf course. Figure 5.2 is a great example of how the use of sand bunkers can create differing illusions. The mounding hills, shapely sand traps combined with the grass and shadows allows for many varying perceptions of the golf hole at any time. The final Figure 5.3, is an example of how not only the change in topography on the hole on which you are playing but also the surrounding topography change enhances the holes illusion. Each of the three figures is a great example of a future hole to be studied. The three figures indicate the change in topography, vegetations, shadows, use of sand traps, and water to be illusions that is desired for future research.

Figure 5.2: Rolling Land Features

Recommendations: A course with more change in topography would help to enhance visual perception of depth. Source: Jones, 1993

The course that was used for this study worked well, but the holes were not as defined by trees and topography as I had originally planned. Louisiana State University golf course was one of the few courses in Baton Rouge, LA that was more than happy to assist in my research and had a consistent group of golfers that were

identified by the golf professional. The use of golf holes with more definition to the boundaries would create a more geometrical shape that should enhance the players' abilities.

5.2 Final Comments

I hope that this thesis will spark interest in future studies of the left and right-brained athlete. Although this study was not entirely conclusive, the study does leave the question as to whether there are differences. This study indicated a slight difference that correlates with the psychological theories behind abilities. If future research indicates a difference, this puts pressure on golf course architects as well as

the Professional Golf Association (PGA) to create golf courses with more equal playing fields. This would require many golf courses to be redesigned to allow for the equality of the differing abilities.

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APPENDIX A: STUDY PARTICIPANT QUESTIONNAIRE

Before you begin, I would like to thank you for taking the time to participate in my thesis research. I am a graduate student in Landscape Architecture at Louisiana State University and my thesis topic is, "The differences in performance for a Left and Right Brained Golfer on a Curvilinear Golf course." The following questions will allow me do decipher whether the left or right brain is dominant in your everyday life. Please answer all of the questions as honestly and completely as possible.

Today's Date:_______________

1. Gender? M or F
2. Are you left or right handed? L or R
3. Do you play golf left or right handed? L or R
4. If you play golf with a different hand than you use everyday, why? ______________________________
____
5. Do you know your handicap? If yes, what is it? ______ If no, what would you guess as your average score? _________

	Prefer			
1. When you walk into a theater, classroom, or auditorium (and assuming that there are no other influential factors), which side do you prefer?	Left	or	Right	Equally preferred
2. Do you believe that there is a right and wrong way to do everything?	Yes	or	No	Equally preferred
3. Do you often have hunches?	Yes	or	No	Equally preferred
4. Setting goals for yourself helps keep you from slacking off?	Yes	or	No	Equally preferred
5. When you are confused you usually go with your gut instinct?	Yes	or	No	Equally preferred
6. Do you keep a "to do" list?	Yes	or	No	Equally preferred
7. Can you tell approximately how much time passed without a watch?	Yes	or	No	Equally preferred
8. Is it easier for you to remember people's names or to remember people's faces?	Names	or	Faces	Equally preferred
9. Would you prefer to express your feelings through drawing or writing?	Drawing	or	Writing	Equally preferred
10. Have you considered becoming a poet, a politician, an architect, or a dancer?	Yes	or	No	Equally preferred
11. When speaking, do you use gestures (that is, do you use your hands when you talk)?	Many	or	Few	Equally preferred
12. Do you tend to control your feeling or are you more open with you feeling?	Control	or	Open	Equally preferred

Thank you again for your time and participation.
If you have any questions or concerns feel free to contact me by e-mail at
[1]rjamis1@lsu.edu

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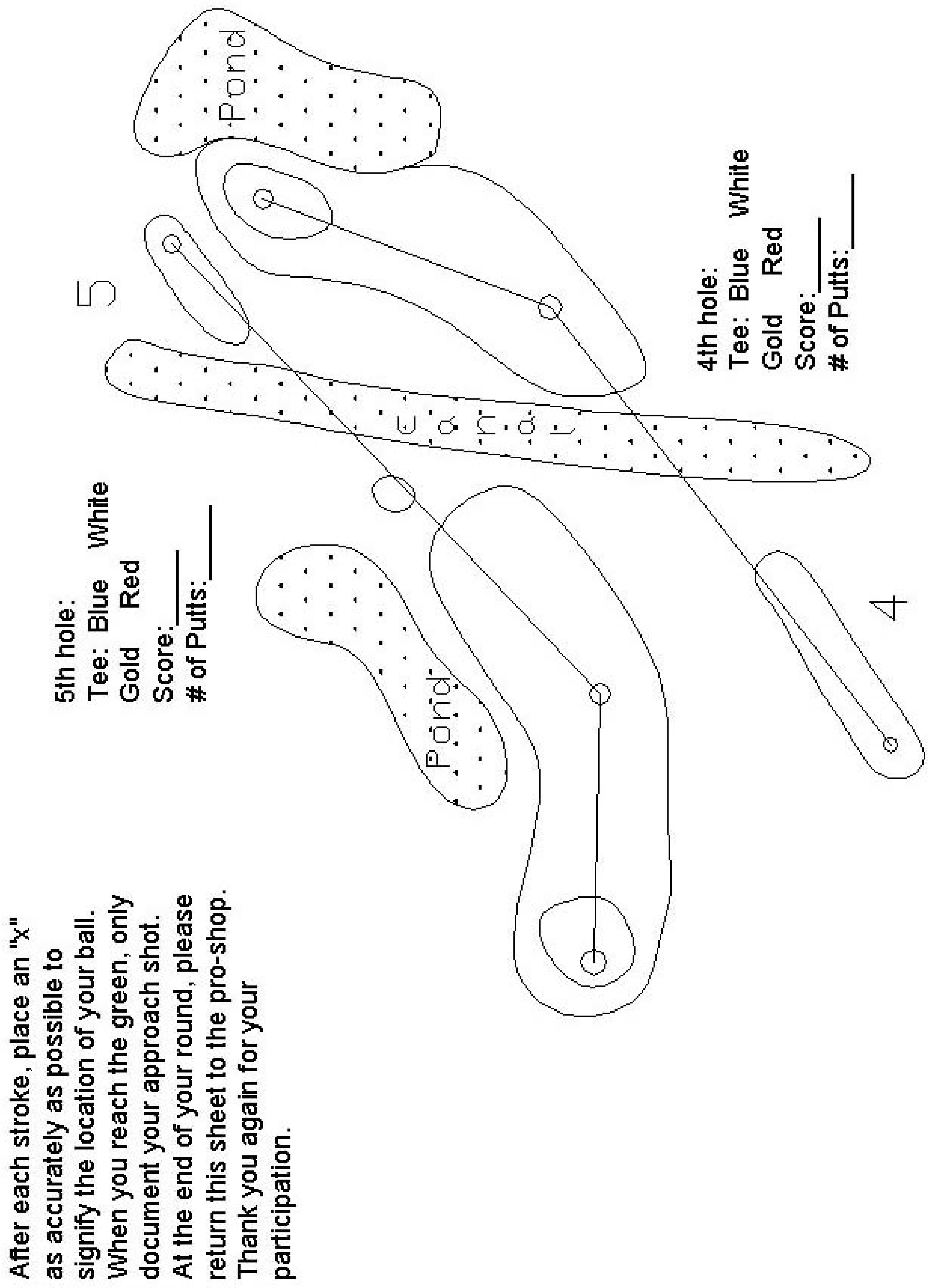
[1] The survey above is a compilation of questions from http://brain.web-us.com/brain/braindominance.htm and http://www.angelfire.com/wi/2brains/test.html

APPENDIX B: PARTICIPANT GOLF SURVEY



APPENDIX C: SAS ANOVA FORMAT

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input hc 1-2 type 3 hole 4 shot 5 stx 6-12 sty 13-19 finx 20-26 finy
27-33 tgx 34-40 tgy 41-46;
cards;

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28R510771.861103.400177.760635.270082.66448.11
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run;
data golfnew;
set golf;
dist = ((tgx – finx)**2 + (tgy-finy)**)**;
run;
title 'shot 1';
data golfs1;
set golfnew;
if shot = 2 then delete;
proc glm;
class type hole;
model dist = type hole type*hole;
run;
title 'shot 2';
data golfs2;
set golfnew;
if shot = 1 then delete;
proc glm;
class type hole;
model dist = type hole type*hole;
run;
quit;
```

VITA

Robin Suzanne Jamison was born in Kansas City, Missouri, on March 4, 1978. In 1982, her family moved to Festus, Missouri, where her parents still reside. She graduated in December of 1999, from the University of Mississippi in Oxford, Mississippi, with a Bachelor of Arts degree in psychology. In 2002, she will graduate from Louisiana State University with the degree of Master of Landscape Architecture.