A COMPARISON OF SECONDARY-SCHOOL LEFT-HANDED AND RIGHT-HANDED WRITERS ON SELECTED DEMOGRAPHIC, ATTITUDINAL, AND ACHIEVEMENT VARIABLES

by

BARRY WOLFE

A Thesis

Submitted to the Faculty of Graduate Studies

The University of Manitoba

In Partial Fulfillment of the

Requirements for the Degree of

Master of Education

Winnipeg, Manitoba

September 1985

ISBN 0-315-33932-2

A COMPARISON OF SECONDARY-SCHOOL LEFT-HANDED AND RIGHT-HANDED WRITERS ON SELECTED DEMOGRAPHIC, ATTITUDINAL, AND ACHIEVEMENT VARIABLES

BY

BARRY WOLFE

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF EDUCATION

TABLE OF CONTENTS

CHAPTER

ACKNOWLEDGEMENTS

This study is dedicated to my wife, Joyce, and my son, Eric. My sincerest thanks for the understanding of the long hours spent away from them in completion of this study. I am truly grateful for the encouragement and support for all my educational endeavors.

I also wish to thank my parents for their encouragement and moral support. Thank you to my left-handed sister, Linda, for providing me with a conceptual reference while completing this study.

My thanks and appreciation to Dr. Ray Henjum, my advisor and committee chairperson, for assistance, help, and encouragement in developing this project. His patience, understanding, and positive attitude were most helpful during the course of this study.

I am grateful to Dr. Lyle Eide, Director of Counselling Services, University of Manitoba, and Dr. Winston Rampaul, Professor, Educational Psychology, for serving as members of the advisory committee. Their support, constructive criticisms, and advice were extremely helpful.

I extend a thank you to Mr. Don McMaster, school principal of Kildonan-East Regional Secondary School, who kindly co-operated in the conducting of the study within the school.

My appreciation is extended to all those students who took the time, effort, and co-operation to complete this study.

ABSTRACT

This research was conducted for the purpose of examining differences between secondary school left-handed and right-handed writers on selected demographic, attitudinal, and achievement variables.

Respondents in the study (N = 120) were tenth and eleventh grade students attending a large Winnipeg secondary high school. The population of the left-handed writers consisted of 60 students. At the tenth grade, there were 21 males and 7 females for a total of 28. At the eleventh grade, there were 19 males and 13 females for a total of 32. A random sample of 60 right-handed writers were selected. The number of right-handed male and female writers matched the left-handed writers' group.

Literature related to left-handedness and the various problems that left-handed people may encounter in both society and school was reviewed.

This investigation employed the use of a questionnaire designed by the researcher, the Harris Tests of Lateral Dominance (1974), the Estes Attitude Scales - Measures of Attitudes Toward School Subjects (1981), the Career Development Inventory (1979), and school subject achievement marks.

Descriptive, inferential, and correlation statistics were used.

Several significant differences between the left-handed and right-handed writers were found. Right-handed writers in this study consistently received higher final school marks, and they had greater measured career development and vocational maturity. A relationship between sinistrality and gender was found. The left-handed writers were more varied in their handedness than the right-handed writers.

Evidence that would support the notion that the sinistral student is at a disadvantage in our school system and, in general, does not perform as well as dextral students was found.

Implications of this study for: 1) school improvements and 2) for further research were presented.

LIST OF TABLES

CHAPTER I

INTRODUCTION TO THE STUDY

Evidence seems to indicate that in our society, there are indeed real differences between left-handers and right-handers. Left-handedness has been linked with a large variety of medical, educational, and social problems. To name a few: epilepsy, dysarthria, cerebral palsy, migraine headaches, reading and writing disabilities, dyslexia, stuttering, mental retardation, alcoholism, psychosis, schizophrenia, and other personality disorders. There is much controversy over the role handedness plays in these deficits. Many studies suggest strong links between handedness and deficits; other studies suggest that such a link is tenuous. The available research evidence is not all that conclusive, and clearly, there is a need for further research, especially that which clarifies problems of handedness within schools.

The purpose of this study will be to examine differences between left-handed writers and right-handed writers within a large Winnipeg secondary high school on selected demographic, attitudinal, and achievement variables.

Background to the Study

Left-handedness is found in approximately ten per cent of the population of the world. The Canadian population is approximately 24 million (World Almanac - 1983, pg. 460) and the world's population is approximately 4.5 billion (World Almanac - 1983, pg. 599); thus it can be estimated that there are approximately 240 thousand left-handed people in Canada, and 450 million in the world. Ten per cent of school populations are left-handed.

Throughout history there has been much prejudice against and negativism associated with the left hand and the left-hander. The left-hander has been very much maligned and has received bad publicity. The left-hander has been discriminated against and has suffered a definite disadvantage. Musical instruments, golf clubs, gum wrapper tabs, can openers, lawn mowers, power saws, cars, playing cards, and one-armed bandits (slot machines) have all been designed to favor right-handed people.

An electric iron has the cord on the wrong side. In a pay telephone booth, the left-hander has to cross over his body to deposit the correct amount of coins. Watches usually have a right-handed winding system. Doorknobs, faucets, or light switches are conveniently placed for the right-hander. At mealtime the coffee cup and silverware are placed to the right of the plate. In restaurants, food is served from the left side, and the left-handers' elbows get in the way. Screws and bolts have right-handed threads. Handshaking, swearing on the Bible, flag saluting, and military saluting are done with the right hand.

The school environment also discriminates against the left-hander. Paper cutters, pencil sharpeners, water fountains, file cabinets,

scissors, and desks are all designed for the ease and enjoyment of right-handed students and teachers. Even pages of a book must be turned from the right to the left. It is a right-handed world in which the right-hander is supreme, exalted, and catered to in everyday life.

In several languages the terms for "left" or "left-handed" often contain derogatory meanings, ranging from clumsy or awkward to evil. The Anglo-Saxon "lyft" means "worthless", "weak", or "broken". The French word for "left", "gauche", means "clumsy", "awkward", or "socially inept". "Mancini" is Italian for "left" as well as for "deceitful", "crooked", and even "maimed". From the Latin, "left" means "sinister", a word rich with evil connotations. The Spanish word for "left" is "zurdo", a word which appears in the idiom "no serzerdo" meaning to be very clever. Its literal translation is "not to be left-handed". "Nolevo" is Russian for "left" or "doing it the sneaky way". The political use of right and left date to the rise of political parties in opposition to the then dominate nobility (Sagan, 1980). The nobles were seated on the king's right and the radical upstarts - the capitalists - on his left (Domhoff, 1970). The nobles were to the monarch's right, of course, because the king himself was a noble, and his right side was the favored position (Sagan, 1980).

Webster's Third New International Dictionary (1977) lists several definitions of the adjective "left-handed", including the following:

a) marked by clumsiness or ineptitude; awkward

b) exhibiting deviousness or indirection; oblique, unintended

c) obsolete; given to malevolent scheming or contriving; sinister, underhand

d) marked by uncertain or ambiguous intent; backhanded, dubious.

Rogets' International Thesaurus (1977) contains these entries:

a) unskillfulness; clumsiness, awkwardness, bumblingness, heavy-handiness, handful of thumbs, left-handedness

b) disrespect; insulting, insolent, alusive, offensive, humiliating, degrading, backhanded, left-handed.

The Synonym Finder (1978) contains the following for the adjective, "left-handed":

ambiguous, double-meaning, paradoxical, doubtful, dubious, equivocal, questionable, enigmatic, ironic, sardonic, indefinite, indistinct, veiled, cryptic, insulting, disparaging, derisive, mocking, disrespectful, clumsy, backhanded, tactless, graceless, crude, gauche.

The English language is no exception. Whoever heard of "doing something the left way", or "a bill of lefts", or "stand for your lefts", or "left on". Perhaps the real clincher is the word "sinister". Originally from Latin, the word "sinister" is equated with wrongdoing, dishonesty, corruption, disaster, and evil. According to Webster's Third New International Dictionary (1977), the first definition of "sinister" is "left, on the left side", and a sinistral is a "left-handed person" (pg. 2125).

The word used for the right hand in Ancient Greece was "dexious". The word "dextral" is from the Latin word "dexter" meaning the right hand. To be dextral is to be right-handed. The Webster's Third New International Dictionary (1977) lists "dextral" as:

a) skillful and active

b) deft and skillful in manipulation.

A further description of the term "right-hand" is as follows:

> the hand of greeting, welcome, or friendship....a reliable or indispensable person: a useful or efficient helper....a place of honor or precendence (sitteth on the right hand of God)....

Roget's Thesaurus Of English Words And Phrases (1982) links dextrality with skillfulness and grace.

The Synonym Finder (1978) contains the following for the adjective "dexterous":

a) Dexterous - adj. - adroit, deft,....handy, neat,.... nimble, agile, quick,....ready, skilled, skillful, proficient, adept, experienced

b) Clever, shrewd,....ingenious, inventive, resourceful, cunning, canny, guileful, subtle, artful, crafty, slick, astute, keen, acute, sharp, sharp-witted, sharp as a tack, quick-witted, sagacious, apt, smart, witty.

c) Masterful, masterly, expert, excellent, polished, finished, well executed....accomplished.

The prejudice against the left hand has been present in many parts of the world for centuries. Christianity, upon which the moral values of our western society are based, is predominantly dextral and discriminates against the left. During the ceremony of the Holy Communion, the sacred elements of the bread and wine are carried from the altar by the minister on the right, who administers them to the communicants from left to right, with the wafer given in the right hand, and the chalice held similarly. The sign of the cross is made by the right hand, the last movement is from the left to right. The

Benediction is always made with the right hand. In countless paintings, the right hand of Jesus is raised in blessing, never the left hand. Left-handed Michelangelo, in his painting of the last judgement, has God pointing the way to Heaven with his right hand, the way to Hell with his left. This famous painting, no doubt, has helped reinforce the prejudice against the left hand. Many a saint revealed his piety in the cradle, clerics later reported, by refusing his mother's left breast (Herron, 1976). The wounds of the crucified Saviour are always on the right side. Jesus is found on the right side of the father.

The Bible repeatedly equates the left hand with evil and sin, while associating the right hand with truth and virtue. In Biblical language, the right hand is almost synonymous with "might", "power", and "the will of the Father" (Thass-Thienemann, 1955). The biases in favor of the right hand begins in the early chapters of Genesis (Barsely, 1977). In the Old Testament, in the Book of Psalms (The New Analytical Bible - Authorized King James Version), the statement is made that the Lord's "right hand is full of righteousness" (48:10); in the Book of Isaiah, it is stated that God spread out the Heavens with His right hand (48:13); and again in the Psalms, that God's "right hand shall hold me". There is no specific information as to what is to be found in the Lord's left hand, or what role, if any, it performed in the creation of the Heavens, and who is held in the left hand.

There are several other references to the right hand in the Book of Psalms - "thou wilt shew me the path of life...at thy right hand there are pleasures for evermore" (16:11); "I have set the Lord always before me: He is at my right hand, I shall not be moved" (16:8); and "for he shall stand at the right hand of the poor, to save him from those that

condemn his soul" (109:31).

The largest number of references to the hand, both left and right is contained in the Psalms (Barsley, 1979, pg. 110). In his book, Left-Handed People, Barsley has listed all the Psalms references - a total of 24 (Barsley, 1979, pg. 110).

In the Book of Judges, left-handedness is associated with warlike tendencies: "among this people there were 700 chosen men left-handed; everyone could sling stones at an hair breadth, and not miss" (20:16).

The biases against the left hand continue into the New Testament. In his description of the vision of the Last Judgement Day, Matthew states:

> When the sons of Man shall come in his glory, and all the holy angels with him, then shall he sit upon the throne of his glory.
>
> And before him shall be gathered all nations; and he shall separate them one from another, as a shepherd divideth his sheep from the goats:
>
> And he shall set the sheep on his right hand, but the goats on the left.
>
> Then shall the King say unto them on his right hand, come, ye blessed of my father, inherit the kingdom prepared for you from the foundation of the world...
>
> Then shall he say also unto them on the left hand, depart from me, ye cursed into everlasting fire, prepared for the devil and his angels:
>
> And these shall go away into everlasting punishment: but the righteous into life eternal (25:31-34, 41, 46).

Perhaps in an overstatement and exaggeration, Barsley (1979) states:

> This vision of Judgement (by Matthew) has been more responsible for "fixing" the prejudice against left-handers than any other pronouncement, and this prejudice has come down through the ages,

> adopted by Inquisitors, judges, soldiers, artists, teachers, nurses, and parents as the supreme example of the association of sinistral people with wickedness and the Devil, whose popular disguise is in the shape of a goat (pg. 15).

One can disagree with Barsley, but it is clear that the association between left, evil, and bad is prominent in the Bible. In all, the Bible uses more than a hundred positive references to the right hand, but very few to the left (Herron, 1976). However, not always was the left hand held in contempt. In the praise of wisdom, the Book of Proverbs states: "Length of days is in her right hand; and in her left hand, riches and honor" (3:16).

In the Islamic religion, the Koran treats the left side and the left-handed no more favorably than does the Bible. Chapter LVI, entitled "The Inevitable", describes the day of judgement. Upon that day, man-kind will be divided into three distinct classes: the companions of the right hand, the companions of the left hand, and those outstrippers who have already earned their place in paradise - ie: the first converts to Mohammedism, or the prophets who were the respective leaders of their people. The companions of the right hand shall have their abode among lote-trees free from thorns, and trees of acacias loaded regularly with their produce from top to bottom; under an extended shade, near flowing waters and amidst fruits in abundance, which shall not fail, nor shall be forbidden to be gathered: and they shall have wives or concubines raised on lofty couches. Those companions of the left hand shall dwell amidst burning winds and boiling waters, under the shade of a black smoke, neither cool, nor agreeable, for they enjoyed the pleasures of life while on earth and persisted in living in sin; their entertainment shall consist of boiling

water and the roasting Hell (Sale, 1927). Furthermore, those know appear before the throne of God on judgement day carrying the Koran in their right hand will be admitted into paradise; whereas those carrying the Koran in their left hand shall be cast into Hell to be burned. The Torah also contains many praises of the right hand (Barsley, 1979, pg. 2).

Other religions, both past and present such as the ancient Zoroastrian faith of Persia, the Aztec and Inca Sun Worship religion, the Shintoism faith of Japan, and the Buddhism creed of Asia all have the same biases against the left hand. However, as Barsley (1979) states:

> to recount equivalent stories and customs from religions other than Christianity would involve a great amount of duplication, since the myths as well as the facts have a distinct similarity (pg. 115).

Throughout the world, the left has been defined as disreputable, radical, murderous, bewitched, profane, impure, and maleficent (Herron, 1976). In parts of Africa, it is believed that if one sees a mongoose on the left side of the path while on the way to visit a sick friend, the friend will die. Seeing the mongoose on the right side guarantees the friend's recovery. Moslems eat and do many honourable actions with the right hand, but to touch another person with the left is a grave social insult. In New Zealand, the Maori people equate the left side of the body with death and protected themselves by wearing amulets and charms on the left.

Thus, as it can be seen, there is great vehemence in the prejudices against the left hand. It is clear that the association between left and bad is of very long standing, and is firmly entrenched throughout the world.

At best we can only speculate as to the origins of this bias. Carl Sagan (1980), in his book, The Dragons of Eden, offers one possibility. Sagan notes that because toilet paper was unavailable in preindustrial societies, the left hand was used for personal hygiene after defecation, a situation still in existence in many parts of the world. This use of one's hand is not only aesthetically unappealing, but it is potentially harmful because it involves a serious risk of transferring disease to others as well as to oneself. These drawbacks can be reduced somewhat by using the other hand to eat and to greet others. Sagan (1980) states:

> without apparent exception in pretechnological societies, it is the left hand that is used for such toilet functions and the right for greeting and eating - lapses from this convention are quite properly viewed with horror...I believe this account can explain the virulence against associations with "left" and the defensive self congratulatory bombast attached to our associations with "right" which are commonplace in our right-handed society (pg. 186).

Since ancient times all human societies have been predominately dextral. Thus, precision tasks like eating and fighting would be delegated to the favoured right hand, leaving by default toilet functions to the left sinister hand. Thus, as Sagan suggests, the left hand became associated with excretory activities, which have a long history of negative associations in human cultures. A chain linking "left" with "bad" was forged. This explanation assumes that historically human beings began with a preference to use the right hand for activities requiring precision and fine control.

Purpose of the Study

The purpose of this study is to examine through the use of a questionnaire, past school records, and selected test instrument measures of performance, the differences between secondary-school left-handed and right-handed writers in respect to the following variables:

1) demographic variables (program of studies, birth order, handedness of parents, handedness of siblings, participation in extra- curricular activities, age, grade, sex, hand dominance).
2) attitudinal variables which consisted of two categories: student self-expressed attitudinal variables (students' attitude towards school, school subjects liked or disliked the most, student self-rating) and test instrument measured attitudinal variables (attitude towards the subjects of English, mathematics, reading, science and social studies, career development, and vocational maturity).
3) achievement variables (final marks achieved in the school subjects of English, mathematics, social studies, physical education, science, and options).

The study also examines whether sex and grade was a factor in the difference between left-handed and right-handed writers in the demographic, attitudinal, and achievement variables.

Research Question

How do secondary-school left-handed and right-handed writers differ on selected demographic, attitudinal, and achievement variables?

Definitions

1. Left-Handed Writers

Those students at the tenth and eleventh grades who identified themselves as being left-handed writers, and who were verified as being left-handed writers by the researcher and the Harris Tests of Lateral Dominance (1974), comprised the left-handed writers' sample for this study. The population of left-handed writers consisted of 60 students. At the tenth grade, there were 21 males and 7 females for a total of 28. At the eleventh grade, there were 19 males and 13 females for a total of 32.

2. Right-Handed Writers

Those students at the tenth and eleventh grades were were randomly selected by the researcher, and who were verified as being right-handed writers by the researcher and the Harris Tests of Lateral Dominance (1974), comprised the right-handed writers' sample for this study. The population of right-handed writers consisted of 60 students. The right-handed writers were matched by grade and sex with the left-handed writers' sample. There were 28 tenth grade and 32 eleventh grade right-handed writers.

3. Main Sub-Groups

This consisted of the two main groupings of all left-handed writers and all right-handed writers at the tenth and eleventh grade levels who were selected for participation in this study. The main sub-group of right-handed writers was composed of 60 students - 28 at the tenth grade and 32 at the eleventh grade. The main sub-group of right-handed writers consisted of 60 students -28 at the tenth grade and 32 at the eleventh grade. The total population of the two main sub-groups consisted of 120 students.

4. Minor Sub-Groups

This consisted of the two main groups broken down into 16 categories - all left-handed female writers, all right-handed female writers, all left-handed male writers, all right-handed male writers, all tenth grade left-handed writers, all tenth grade right-handed writers, all tenth grade left-handed female writers, all tenth grade right-handed female writers, all tenth grade left-handed male writers, all tenth grade right-handed male writers, all eleventh grade left-handed writers, all eleventh grade right-handed writers, all eleventh grade left-handed female writers, all eleventh grade right-handed female writers, all eleventh grade left-handed male writers, and all eleventh grade right-handed male writers.

5. Demographic Variables

Demographic variables were determined by the students' responses to the questionnaire, and the Harris Tests of Lateral Dominance (1974). These variables were comprised of the respondents' program of studies, birth order, handedness of parents, handedness of siblings, participation in extra-curricular activities, age, grade, sex, and hand dominance.

6. Student Self-Expressed Attitudinal Variables

The student self-expressed attitudinal variables were determined by the students' responses to questions on the questionnaire. These variables comprised of students' attitude towards school, school subjects liked or disliked the most, and the respondents rating themselves as students.

7. Instrument Measured Attitudinal Variables

The student attitudinal variables were measured by test instruments which consisted of the Secondary form of the Estes Attitude Scales - Measures of Attitudes Toward School Subjects (1981), and the Career Development Inventory (1979). The Estes Attitude Scales measured subject attitudes in five areas - English, mathematics, reading, science, and social studies. The Career Development Inventory measured attitudes in career development and vocational maturity in the following areas - Career Planning (CP), Career Exploration (CE), Career Decision-Making (DM), World-of-Work Information (WW), Knowledge of Preferred Occupation (PO), and Career Development Orientation Total (COT).

8. Achievement Variables

Achievement variables were determined by a check of school records and the questionnaire. Final marks at the tenth and eleventh grades were determined in the school subjects of English, mathematics, social studies, physical education, science, and options. On the questionnaire, the respondents were requested to list the school subject in which they received their highest mark, and the school subject in which they received their lowest mark.

Limitations of the Study

The samples used in this study were limited to those tenth and eleventh graders presently in attendance at Kildonan-East Regional Secondary School. Thus, the results generated from this study may only be confined to that population studied within the confines of the school.

The high school is located within the River East School Division, with a population of 1350 students. Approximately one-third of the school population comes from outside the immediate area. This school draws students from six school divisions (Fort Garry, St. Boniface, St. Vital, Seven Oaks, Transcona-Springfield, and River East).

CHAPTER II

REVIEW OF THE LITERATURE

In the chapter which follows, a review of the literature related to left-handedness and the various problems that left-handed people may encounter in both society and in school is presented.

This chapter will include (a) literature and research on handedness, (b) how handedness is related to demographic variables, (c) how handedness is related to attitudes, and (d) how handedness is related to achievement. The chapter is presented in three major sections: the measurement and prevalence of handedness, theories and types of handedness, and left-handedness and schooling. These three major sections are further divided into other smaller sections.

The first major section describing measurement and prevalence of handedness is divided into the following divisions: the measurement of handedness, neuroanatomy, hemispheric specialization, and handedness, the incidence of handedness - the historical record, handedness and deficit, gender and handedness, and handedness as a learned phenomenon.

Measurement and Prevalence of Handedness

The Measurement of Handedness

There is a difficulty in determining the correct handedness of a person, as handedness is not a truly dichotomous variable. Often the division into right- and left-handers is merely arbitrary (Annett, 1972;

Corballis and Beale, 1976). A large variety of hand preference is possible. There are, for example, dextral writers who throw or deal playing cards with the left hand and sinistral writers who throw, hammer, or use scissors with the right hand (Annett, 1970). There is a broad band of varying preference and no clear-cut division between left and right. In some ways, talking about "left-handedness" and "right-handedness" is much like discussing the terms "tall" and "short". Unless one has an objective basis for reference, the terms in themselves are relatively useless. In attempts to determine handedness scientifically and objectively, testing for handedness has been treated in several ways. It can be argued that none of these test methods are entirely satisfactory.

Self-report is a common method used to assess handedness, whether by means of simple self-categorization or by means of detailed questionnaires. For example, Rife (1940) used a questionnaire in which subjects rated themselves right-handed, left-hinded, or ambidextrous on ten criteria: throwing, bowling, shooting marbles, holding a knife, using a spoon, swinging a hammer, sawing, sewing, writing, and cutting with scissors. Only those who claimed to use the right hand for all ten operations were designated right-handed, while all others were designated left-handed. Other studies have each used different techniques to assess handedness. The terms "left" and "right" are fairly simple but have been used in almost as many ways as there have been writers on the topic since consistent criteria of left-handedness have not been adopted. McMeekan and Lishman (1975) discussed the reliability and merits of two of the more popular tests for handedness - the Annett hand preference questionnaire (Annett, 1970), and the

Edinburgh Handedness Inventory (Oldfield, 1971). They found both wanting in their ability to determine handedness. Hardyck and Petrinovich (1977) reviewed many techniques and approaches used to determine handedness and found none ideal. As Hecaen and De Ajuriaguerra (1964) state:

> the methods used for estimating right- and left-sidedness are innumerable and of unequal value. It can be said that each investigator has used his own methods or has modified the questionnaires or batteries of tests used by other investigators (pg. 20).

Thus, it is not surprising that estimates of the incidence of left-handedness have ranged from as little as 1 per cent to as much as 30 per cent (Hecaen and De Ajuriaguerra, 1964). Handedness is not a simple phenomenon that is easily determined. Perhaps as some researchers have suggested (Oldfield, 1971; Annett, 1972) handedness is a variable along a continuum.

On one end we find individuals who are strongly right-handed in all tasks. They have no family history of left-handedness and are highly lateralized for speech and spatial functions: the verbal functions being left hemisphere lateralized and the spatial functions being right hemisphere lateralized. On the other end of the continuum are those left-handed individuals with a family history of left-handedness and who have both speech and spatial functions bilaterally localized. Bridging the two ends of the continuum are: (1) the right-handed with a family history of left-handedness who show some bilateralization of verbal and spatial function, at least to a greater extent than do the right-handed with a negative sinistral family history, but less than do the familial left-handed, and (2) the left-handed with no family history of sinistrality, but have some

bilateralization of function.

Although hand preference is to be viewed as a variable along a continuum, it is still possible to distinguish individuals who belong to the different regions of the continuum. One way such a distinction can be determined is based upon the hand preferred for writing. The easiest and most general classification of handednesss is the binary one into dextral and sinistral writers. As Annett (1970) states, "writing discriminates as effectively as any other action....between those who are relatively more dextral than sinistral" (pg. 316). However, there are a few individuals who write with the left hand, but draw with the right hand (Oldfield, 1971). The author of this study knows an individual who writes with the right hand but does every other activity with the left hand.

This study is limited to those secondary level students as identified at the tenth and eleventh grades who write with their left hand.

Neuroanatomy, Hemispheric Specialization, and Handedness

Following is a broad and general outline of the neuroanatomy and function of the human brain. For readers with little or no knowledge about the human brain, this is essential to understanding how handedness works and exists.

The Human Cerebrum. The human brain, when mature, weighs about 1,500 grams - a bit over 3 pounds - which makes it one of the heaviest organs in the body. It consists of a mass of nerve tissues occupying the entire cavity enclosed by the skull. It consists of the cerebrum, cerebellum, pons, and medulla oblongata, and is continuous with the spinal cord. Our interest is with the upper part of the

brain - the part called the "cerebrum" (from the Latin word for brain). The human cerebrum is very large, constituting about half the weight of the entire nervous system. Indeed, it is so large that, in order to fit into the narrow confines of the skull, the brain has literally folded inwards into itself. It has a great number of ridges and surface folds. These ridges and folds greatly increase the amount of cerebrum covering or "cortex". The curves, wrinkles, and folds of the cortex appear in virtually the same place in all human brains and thereby demarcate particular cortical regions, lobes or divisions.

The cerebrum is divided into two parts. A deep longitudinal groove, or fissure, that runs along the cerebrum's midline divides it into two essentially mirror-image parts or "hemispheres". The two hemispheres are joined together by a massive bundle of interconnecting nerve fibres called the "corpus callosum". The left hemisphere is often called the "dominant" or "major" hemisphere, and the right hemisphere is often called the "minor" hemisphere. However, based on the available evidence, to call one hemisphere "dominant" and one "minor" is to make a value judgement rather than a scientific judgement.

Contralateral Innervation. The hemispheres are linked to the body "contralaterally" (opposite end) rather than "ipsilaterally" (same side), so that the left side of the body is controlled mainly by the right hemisphere, and the right side of the body is mainly controlled by the left hemisphere. The functional and evolutionary significance of this contralateral design is not clear.

This means that the left hand is primarily neurally controlled by the right cerebral hemisphere, and the right hand by the left hemisphere. Thus, when an object is felt with the left hand, the tactual

sensory information specifying its shape, weight, texture, etc., travels primarily to the right hemisphere.

Hemispheric Specialization. Information, rather than being confined to one hemisphere, travels to the other hemisphere via the corpus callosum. In a real sense, the corpus callosum lets the two hemispheres communicate with one another.

The hemispheric organization of the brain is unique to our body. All other paired internal organs of the body, such as the lungs, kidneys, or ovaries have identical functions, and an individual can get along quite well with only one of each. However, in the case of the two human cerebral hemispheres, a different situation exists. There is an asymmetry of function, even though, physically, the two hemispheres appear to be symmetrical or identical. The left and right hemispheres are not identical in their capabilities or organization. The division of responsibilities between the hemispheres is unique to humans only (Bailey, 1975). Nonhuman mammals have not been demonstrated to possess cerebral specialization in any manner similar to humans - that is, no double dissociations have been reported in nonhuman mammals (Hicks and Kinsbourne, 1978). All vertebrates have twin hemispheres in their brains, but the hemispheres are truly twins, each capable of doing whatever the other does (Bailey, 1975).

We have only to examine the abilities of our two hands to see the asymmetry of function. Few people are truly ambidextrous; most have a dominant hand. A person's handedness tells us a great deal about the organization of a person's hemispheres.

Differences in the abilities of the two hands are but one indication of basic asymmetries in the functions of the two cerebral hemispheres.

Evidence for these basic asymmetries has accumulated in recent years through a variety of techniques. The earliest evidence of functional asymmetries came from the observation and analysis of the behavior of individuals with brain damage - for example: war wound, automobile accident, bullet wound, tumor, and so forth. In the 1960's, Roger Sperry's work at the California Institute of Technology on patients who had their corpus callosum surgically cut (split-brain patients) to control epilepsy gave us valuable information on hemispheric asymmetries.

Encouraged by the discoveries with brain-damaged and split-brain patients, investigators have sought ways to study hemispheric differences in neurologically-normal people. Ideally, one would like to know differences between the left hemisphere and the right hemisphere found in brain-damaged and split-brain individuals has any conse- quences for the function of the normal brain.

Researchers have developed several different ingenious techniques to answer this question. Special techniques make it possible to confine detailed sensory information to just one hemisphere in the normal person. The limiting of stimuli to one hemisphere is often called lateralization. By injection of the drug Sodium Amytal into the brain and by employing dichotic listening tests, tachistoscopic tests, conjugate lateral eye movement tests, and unilateral electroconvulsive therapy, scientists have been able to study the functions of the two hemispheres in a normal person. It is clear from the research that there are differences in function between the two sides of the brain in normal individuals.

The left hemisphere is specialized for speech and language functions. The right hemisphere is relatively "mute" but is specialized for visuo-spatial perceptual functions. Thus, a person feeling an object with his left hand (but not look at it) is able to describe the object

because the tactile-sensory-information relayed to the right "spatial" hemisphere travels through the corpus callosum to the left "verbal" hemisphere where it can be described in language.

Hemisphericity. Not all people are equally lateralized. Individuals have a tendency to rely on one hemisphere and its mode of thought more than the other (Krashen, 1975). The left hemisphere has been characterized as working in a rational, linear, logical, analytic, sequential, or serial way. These functions lend themselves to development of verbal skills.

The right hemisphere, by contrast, is primarily a synthesist working in terms of wholes or gestalts. This kind of processing is suitable for the detection and analyzing of spatial information. This distinction between the left and right hemispheres has been described as: symbolic versus visuospatial, association versus apperceptive, propositional versus appositional, and analytic versus gestalt (Nebes, 1975). Ornstein (1977) describes the left hemisphere as being rational, verbal, and active, whereas the right hemisphere is intuitive, spatial, and receptive. Thus, the organization and processing of information by the right hemisphere is in terms of gestalt wholes and having a predisposition for perceiving the total rather than the parts. The right hemisphere is holistic and intuitive (Herron, 1976). By contrast, the left hemisphere processes information linerally and sequentially and associates the relevant details with verbal symbols.

Ornstein (1977) claims that the differences between the hemispheres clearly show the traditional dualisms of intellect versus intuition, science versus art, and the logical versus the mysterious. He further suggests the logical mathematicians and intuitive artists use different

halves of the brain in their work.

Bakan (1971) claims that everyone may be classified as a right hemisphere person or as a left hemisphere person, depending on which hemisphere guides the bulk of an individual's behavior. Similar differences have been noted between the left-handed and the righthanded. Lefthanded people have a functional cerebral organization that is different from that of right-handed people. As a group, left- handed people are not as homogeneous as right-handed people. There is a more diversified pattern of cortical representation, which varies with the individual (either a dominant right hemispheric representation, a dominant left representation, or a bilateral representation) and a more diffuse and less centralized arrangement of the various functional aspects within a single hemisphere. As a result, left-handers are "different", but not necessarily better or worse than right-handers. This thesis will address itself to measurement of some of these differences as found in one large high school.

The Incidence of Handedness - The Historical Record

It is common knowledge that all of the world's contemporary societies are predominately dextral (Coren-Porac, 1977). Studies conducted in the United States (Chamberlain, 1928; Rife, 1940), Britain (Annett, 1973a; Oldfield, 1971), Western Europe (Hecaen and De Ajuriaguerra, 1964), Japan (Komai and Fukuoka, 1934), the Solomon Islands (Rhoads and Damon, 1973), and various African and Asian nonliterate cultures (Dawson, 1972) (Verhaegen and Ntumba, 1964) show that at least 90 per cent of the human population uses the right hand for most skilled activities. But was it always so? Although the amount of evidence is limited and difficult to obtain, the existing data suggests

that the incidence of handedness in ancient man is not essentally different from the ratios found today (Brinton, 1896; Black, Young, Pei, and De Chardin, 1933; Dart, 1949; Magorin, 1966).

One of our earliest ancestors was Australopithecus-Africanus who lived approximately 6 million years ago. Evidence for right hand preference in early man comes from an analysis of fossilized baboon skulls with fractures. A South African anthropologist, Raymond Dart (1949) studied 47 fossil remains of baboon skulls found (in Africa) under circumstances that suggested that they had been killed as food by Australopithecus who wielded hand held weapons of wood, bone, or stone. Dart concluded that Australopithecus had a preference for the right hand. Of these baboon skulls, less than 5 per cent appeared to have received blows from the left hand of Australopithecus.

A study (Magorin, 1966) of tracings of the human hand believed to have been made by Cro-Magnon man, shows over 80 per cent to be of the left hand. If it can be assumed that the artists traced their own hand, then perhaps we can assume that it points to a very strong preference for the right hand in skilled activity.

Dennis (1958) examined drawings of people found inside the Egyptian tombs of Beni Hasan and Thebes. The Beni Hasan drawings were done about 2,500 years B.C. Based on these drawings, Dennis (1958) concluded:

> A preference for the use of the right hand in skilled acts was present in Egypt at least as early as 2,500 B.C. Skilled acts inclued writing, which at that time, was a relatively new art.... the right hand was commonly preferred (pg. 149).

Coren-Porac (1977) surveyed more than 5,000 years of art, encompassing 1180 pieces of drawings, painting, and sculptures. The

earliest sample included was dated at approximately 15,000 B.C., the latest in 1950 A.D. These works of art were drawn from Asia, Africa, Europe, and America. The survey showed that the right hand was used an average of 92.6 per cent in the artistic creations. Coren-Porac concluded that: "As far as the historical record takes us, man appears to have always been right-handed" (1977, pg. 632).

The first written record of the incidence of left-handedness is found in the Book of Judges (The New Analytcal Bible-Authorized King James Version), which describes the Benjamite army of 26,700 men (20:15). Among this army was a group of 700 left-handed men chosen from Gibeah, who all could "sling stones at an hair breadth, and not miss" (20:16). If we use this information to calculate a ratio of left-handedness we obtain the figure of 2.62 per cent (26,700/700) a rather low ratio of left-handedness, until we consider that there is no evidence that the other 26,000 soldiers were all dextral.

Thus, based on the available evidence and historical record, it appears that man's ancient ancestors were predominately right-handers. It appears that distinction runs deep into the past of our species. Why this is so is still the subject of much speculation. Perhaps this is what makes us unique and separate from other animals on our planet, although the available evidence is confusing and unclear.

Investigations (Tsai and Maurier, 1930; Finch, 1941; Ettlinger, 1946; Collins, 1968, 1969; Dewson et al., 1970; Dimond, 1972; Groves and Humphrey, 1973; Robinson and Voneida, 1973; Levy, 1974; Gulliksen and Voneida, 1975) have looked for paw (hand) or limb preferences in animals and have found that several species do show preferences. In such experiments, the animal is usually required to perform a task which permits only the use of one paw (hand), for

example, to reach through a hole to obtain an item of food. If the animal consistently employs the same paw (hand) then it is said to show a preference for the use of the paw (hand). Cats typically use one paw in tasks that involve reaching for an object. Monkeys too use one limb predominantly in unimanual tasks. Even mice show consistant preference in a task in which they must use one paw at a time to reach for food.

In general, most animals show a high degree of ambidexterity, and either paw (hand) may be used to secure food objects. Only a small proportion show a strong preference for either the use of the right or left paw (hand). The number of ambidextral animals consistently out-numbers those showing a preference. Generally, the proportion of animals showing a preference for the right is the equal of that showing a preference for the left. In other words, approximately 50 per cent of cats, monkeys, and mice show a preference for the right paw (hand) and 50 per cent a preference for the left.

This is strikingly different from the breakdown found in human beings: 90 per cent right hand preference, 10 per cent left hand preference. Thus, we can say with some assurance that the forwarded paw (hand) in animals showing a preference is equally likely to be the left or the right. Human beings appear to be the only animal with a strong dextral tendency.

Handedness and Deficit

Left-handedness has been linked with a variety of deficits such as reading disabilities, speech defects such as stuttering, writing disabilities, dyslexia, epilepsy, dysarthria, cerebral palsy, mental retardation, enuresis, motor awkwardness, alcoholism, personality disorders,

migraine headaches, and childhood allergies.

One recent study (Geschwind and Behan, 1982) found that learning disabilities were 12 times more frequent in the left-handers than in the right-handers, and at least three times more frequent in the left-handers' relatives. Geschwind and his colleagues also linked left-handedness to language disorders (such as dyslexia), migraine headaches, and autoimmune diseases (such as ulcerative colitis, myasthenia gravis, and celiac disease, in which the body attacks its own tissues). Ohlendorf (1982) states that left-handers are at least twice as likely as right-handers to suffer from stuttering and learning problems.

In a paper titled "The Sinister Child" (1974), American psychologist Theodore H. Blau concluded the following:

1. Left-handed children are more likely to be reported as having significant physical and behavioural problems during the first 5 years of life than are right-handed children.
2. They are more likely to have preschool adjustment problems and first grade achievement problems.
3. They are more likely to have reading, arithmetic, and speech problems.
4. Their intellectual performance is likely to be more variable.
5. The age at which bedwetting stops is likely to be later among mixed- or left-handed children.
6. Left-handed children are likelier to show certain socially unacceptable behavioral traits, including stubbornness, difficulty in completing projects, difficulty in following directions, impulsivity, a tendency to be socially embarrassing to the family, a penchant for creating war

within the family, difficulty in learning from experience, and oversensitivity.

7. Left-handed children are more likely to show symptoms of poor sleep, headaches, and dizziness.

A higher incidence of left-handedness has long been reported in clinical populations (Hecaen and De Ajuriaguerra, 1964; Bakan, 1971; Satz, 1972; Hicks and Barton, 1975; Silva and Satz, 1979; Geschwind and Behan, 1982).

In the mentally retarded, the incidence of left-handedness is usually reported to be between 17 to 20 per cent (Hicks and Kinsbourne, 1976b), which is a greater incidence of left-handers than that found in the normal population. Hicks and Barton (1975) have reported that left-handers are more prominent among the severely and profoundly retarded than among the mildly or moderately retarded.

Gender and Handedness

In comparison to females, males suffer from a greater variety of problems. According to Swerdloff (1975), males are more vulnerable than females to bronchial asthma and brucellosis, gastric ulcers and gout, harelips and hepatitis, tuberculosis and tuleremia, stuttering and color blindness. Males also suffer more often from heart disease than females, and they die more often of cancer. More male babies die in childbirth than female babies, and more males die in every succeeding year of life. The life expectancy for women is greater than for men in virtually every country where it has been measured (Swerdloff, 1975). The sex ratio of males to females for dyslexia is four to one (Flor-Henry, 1978). Males exhibit more epilepsy - a sex ratio of 1.4

to 1 (Taylor and Ounsted, 1971), and more unsocialized aggressive behavior (Offord, 1971). Over 95 per cent of the hyperactive children are males (Restak, 1980, pg. 230). In a review of the available literature, Flor-Henry (1978) found that males are more susceptible to: childhood epilepsy, infantile autism, aphasia, dyslexia, reading retardation, conduct disturbances in childhood psychopathy, and schizophrenia. The only two "ailments" that females suffer more than males are cancer of the reproductive organs and diabetes.

The connection between sinistrality and males is stronger than in females (Hecaen and De Ajurreguerra, 1964; Oldfield, 1971; Satz, 1973; Flor-Henry, 1978; Barsley, 1979; Blakeslee, 1980; Marx, 1982).

Schachter (1970) found:

1. dyslexia and sinistrality three times more common in males than females;
2. aphasia and stuttering with a sinistral association to be five times more common in males.

Nagylaki and Levy (1973) noted that males are more susceptible than females to prenatal and natal pathology. Rosanoff, Handy, and Plesset (1937) found that in opposite-sexed twins the male had the lower I.Q. The incidence of left-handedness is higher in males and in twin births both of which are associated with greater birth and infant mortality (Bakan, 1971). Weiner et al. (1965) found that even singly born males manifest more neurological damage than females. More male infants experience spontaneous abortions (Bakan, 1971).

Handedness as a Learned Phenomenon

It has been claimed by some that handedness is a learned trait. Blau (1946) claims that right-handedness is learned, whereas left-handedness is a "deviation in the learning process which normally leads to dextrality" (pg. 93). The deviations in learning are due to "an inherent deficiency, physical or mental, faulty education, or emotional negativism" (pg. 117). He virtually fails to provide any evidence of such statements.

In a review of the topic, Hicks and Kinsbourne (1976b) concluded: "There is little evidence in support of a learning-modelling hypothesis for handedness" (pg. 261).

Theories and Types of Handedness

This section describing theories and types of handedness is divided into the following sections: genetic theories, brain damage and left-handedness, psychopathy and left-handedness, autism, schizophrenia, and alcoholism.

Genetic Theories

There have been many attempts and studies to develop and analyze genetic models for left- and right-handedness (Annett, 1964, 1967, 1972, 1973a, 1973b, 1974, 1975; Colins, 1968, 1969, 1970, 1971; Bradbury, 1912; Chamberlain, 1928; Falek, 1959; Hudson, 1975; Jordan, 1911, 1914; Levy and Nagylaki, 1972; Newman, 1931; Ramaley, 1912, 1913; Rife, 1940, 1950; Schott, 1931; Trankel, 1950, 1955) but the results are far from conclusive. Perhaps the principal proponent of a non-genetic explanation is Collins (1968, 1969, 1970, 1975), who has argued that handedness can be accounted for without recourse to

genetic considerations, a position strongly opposed by proponents of genetic models (Nagylaki and Levy, 1973; Hicks and Kinsbourne, 1976a, b).

Hecaen and De Ajuriaguerra (1964) concluded: "it follows....that the heredity mechanism cannot play the only part, and that other factors are necessary to account for the problem of left-handedness in its entirety" (pg. 20). Similarly, Corballis and Beale (1976) suggested that: "left-handedness is neither wholly pathological nor wholly genetic" (pg. 138).

Brain Damage and Left-Handedness

The incidence of left-handedness in twins is approximately twice that among the singly born (Corballis and Beale, 1976).

Evidence cited by Nagylaki and Levy (1973) show that although the percentage of left-handedness among twins is significantly greater than among the single born, there is no significant difference in this percentage between monozygotic (identical) and dizygotic (fraternal) twins.

Gordon (1920) first proposed the idea that minor brain damage may underly much of the left-handedness in twins. He found that among 219 pairs of twins, eight cases were seen in which one twin was in a school for the mentally handicapped, and in all eight cases it was the left-handed twin of a discordant pair.

In his studies of monozygotic and dizygotic twins, Slater (1961) found that twins had lower birth weight, poorer health, and greater probability of being left-handed or ambidextrous.

Nagylaki and Levy (1973) maintain that the increased left-handedness in twins is a direct result of the increased pathology

associated with twinning in the womb, such as uterus crowding.

Newman (1940) has described the hazards faced by all twins:

> Adequate statistics show that, on the average, from three to four times as many two-egg twins and from six to seven times as many one-egg twins are born dead as is the case with the singly born....The main cause of the excessive prenatal mortality of twins....is crowding, using this term in the broad sense to include all damaging effects due to interference of one fetus with another.
>
> One of the chief hazards of twins is an indirect effect of crowding, for lack of room in the uterus very frequently forces the fetus, one or both to occupy positions that are unfavorable to normal birth....In over a third (of twin pregnancies) ....one twin had a head presentation and the other either a breech or crosswise presentation.... Such positions....involve a greater likelihood of birth injuries....
>
> Premature birth is extremely prevalent among twins ....The proportion of twins born prematurely averages over 50 per cent....A premature infant is far more delicate and more easily injured at birth than a full term baby. Especially vulnerable is the brain....Even minor hemorrhages, while not fatal, may result in subsequent mental or nervous defects.

The strongest point to emerge from Nagylaki and Levy (1973) is that twins are more likely to be left-handed than are the singly born, probably because of prenatal environment stress. However, this is not to say that the factors which determine handedness in twins are different in kind from those which determine handedness in the singly born. It has been claimed that left-handedness is always a result of brain damage caused by cerebral anoxia associated with birth stress, on the grounds that left-handed and ambilateral persons are about twice as likely to have suffered known birth stress than are right-handers (Bakan, 1971; Bakan, Dibb, and Reed, 1973; Corballis and Beale, 1976).

Paul Bakan (1973) contends that left-handedness is not inherited but caused by minor brain damage sustained during pregnancy or birth.

Bakan, Dibb, and Reed (1973), in their study of 510 university students, found that left-handed and ambilateral subjects reported birth stress about twice as often (41 per cent) as right-handed subjects (22 per cent). In the study, the subjects were asked to list on a questionnaire any known stress conditions known to be associated with their birth. Conditions listed were: multiple birth, premature birth, prolonged labor, caesarian birth, breech birth, blue baby, and breathing difficulties at birth.

Brain damage can result from a reduced supply of oxygen to a developing fetus or a baby in the process of being born. The left cerebral hemisphere seems to have a greater need for oxygen and blood, and has a more active metabolism (Riklan and Levita, 1970; Bakan, 1971; Ingvar, 1976; Gur et al., 1982) and is therefore especially vulnerable to the effects of anoxia. Thus, anoxia due to prenatal and natal stress is more likely to interfere with left hemisphere functions (Bakan, Debb, and Reed, 1973).

Since the left hemisphere controls the right hand, there is a shift to left-handedness and/or ambidextricity. Furthermore, left-handedness and ambilaterality would be associated with other functions controlled by the left hemisphere such as speech and language functions. Indeed, it has often been noted that left-handedness and ambilaterality are more prevalent among those with language disorders such as stuttering, dyslexia, agraphia, and mental retardation (Orton, 1937; Zangwill, 1960; Hecaen and De Ajuriaguerra, 1964;)

Other findings from the study (Bakan, Dibb, and Reed, 1973) were:

a) Left-handed and ambilateral subjects were more likely to have at least one left-handed or ambilateral relative. About 69 per cent of left-handed and 62 percent of ambilateral subjects reported at least one left-handed or ambidextrous relative; whereas this is true of 46 percent of the right-handed subjects in the study.

b) Those who were first born to older mothers (age 30 or more), a group subject to greater risk for birth stress, had a higher incidence of left-handedness and ambilaterality. Of the left-handed and ambilateral subjects for whom birth order and maternal age information were available, about 17 per cent were first born to mothers aged 30 or more. Left-handed and ambilateral subjects were significantly found more often among the first born to older mothers than among other subjects.

c) Subjects with at least one left-handed or ambilateral relative are more likely to report birth stress regardless of their own handedness.

There may be a familial factor associated with left-handedness, and a relationship between familial left-handedness and birth stress. The study suggested that perhaps the familial tendency to left-handedness is mediated by a familial tendency to birth stress. This familial tendency to birth stress may be related to such factors as pelvic, uterine, placental anatomy, hormonal factors, nutritional factors,

vascular abnormalities, and pain sensitivity influencing the need for anaesthesia, etc. These factors may have a genetic component or may be due to other biological or environmental factors. The study felt that the notion of a gene for left-handedness was too simple of an explanation for the familial tendency for left-handedness (pg. 365).

Thus, the fact that the incidence of left-handedness is higher in males and in twin births, both of which are also associated with greater birth stress and infant mortality, and in mentally retarded or epileptic groups, where the central nervous system pathology is implicated, had led Bakan, Dibb, and Reed (1973) to hypothesize that there is a strong relationship between left-handedness and early brain insult.

To account for higher incidence of left-handedness among the brain damaged population, as well as some of the left-handedness in the population at large, Paul Satz (1972, 1973) offers an explanatory model of "pathological left-handedness". His explanation was that early damage to the left hemisphere causes a mild hypofunction of the contralateral hand, in natural right-handers, which in turn, causes the child to switch to the opposite hand for manual activities such as writing. Thus, a certain proportion of natural right-handers, because of early left brain insult, became pathological left-handers. Since natural left-handedness, genetic or cultural, is less frequent (Saltz and Silva, 1979) than natural right-handedness in normal populations, the absolute number of natural left-handers who became pathological right-handers following damage to the right hemisphere would be small compared to the number of natural right-handers becoming pathological left-handers following left brain dysfunction.

Satz's model of the "pathological left-hander" helps to account for the high incidence of left-handedness among the brain damaged and

mentally retarded populations. The incidence of left-handedness is usually reported to be between 17 and 20 per cent which is substantially higher than the 8 to 10 per cent rate most frequently reported for a normal population (Saltz and Silva, 1979).

Although some left-handers may have suffered early brain injury, it is most unlikely that all left-handers are brain damaged. The overwhelming majority of left-handed people are normal in intellectual and physical capability. There are many famous and well known "lefties" who simply exalt too greatly to be called brain damaged. For example, a partial list includes: Queen Victoria, Leonardo Da Vinci, Pablo Picasso, Michelangelo, Napoleon, Harry Truman, Gerald Ford, Charlie Chaplin, Rock Hudson, Robert Redford, and Prince Charles.

Left-handedness may represent the tip of the iceberg of birth defects caused by cerebral anoxia. It may be the most frequent and most benign symptom of left hemisphere anoxia when it appears alone. The relative frequency of left-handedness and ambilaterality in various groups might serve as a general index of the prevalence of birth-related neurological damage.

Psychopathy and Left-Handedness

Anomalous distribution of handedness has been reported in various clinical conditions. A high proportion of sinistrality has been associated with psychopathy (Quinan, 1930; Porac and Coren, 1981), psychiatric patients in general and psychotics in particular (Lishman and McKeekan, 1976), and its reported excess in epilepsy and subnormality has been reviewed by Hecaen and De Ajuriaguerra (1964). Left-handedness has been related to emotional instability (Orme, 1970), and has been associated with "general maladjustment" (Palmer, 1963).

A predominance of left-sided occurrence has been reported for certain psychogenic symptoms. These include conversion hysteria (Galin et al., 1977; Stern, 1977), pain (Merskey and Spear, 1976), hypochondriasis (Halliday, 1937; Kenyon, 1964), and rheumatism (Halliday, 1937, 1941; Edmonds, 1947). Several studies have shown that both sinistral and dextral patients experienced the greatest effects on the left side.

Lishman and McKeekan (1976) suggested that the increased level of sinistrality among psychotics may be linked to early left hemisphere damage. Their study also showed that left-handedness was more prevalent in manic depressives and schizoaffectives than in the purely schizophrenic patient. Other studies have given support to the hypothesis that disturbances in cerebral dominance and perturbed interhemispheric organization causes psychoses (Lishman and McMeekan, 1976; Fleminger et al., 1977; Flo-Henry, 1978; Smokler and Shevrin, 1979; Flo-Henry and Kotes, 1980) Perhaps people who display unusual patterns of handedness or cerebral dominance are also more vulnerable to stress and to psychiatric breakdown (Lishman and McKeekan, 1976).

The study of Fleminger et al. (1977) confirmed the findings of Lishman and McKeekan (1976). Both studies found that, on the whole, the proportion of sinistral psychotics was higher among males than females.

Thus, there is evidence to link sinistrality with psychosis, but as usual in these situations, there have been contradictory findings (Fagan-Dubin, 1978; Fleminger, Dalton, and Hsu, 1978; Adams and Awamutu, 1978), indicating that perhaps more research could be done in the area of left-handedness and psychosis.

Autism

Some informal observations of autistic and normal children playing with a computer controlled audiovisual display (Colby and Kraimer, 1975) led to the notion that the distribution of their handedness was different in the two groups.

Hauser, Delong, and Rosman (1975) reported that eight out of their 17 autistic children (47 per cent) were left-handed, and three others had failed to establish dominance. Colby and Parkinson (1977) investigated the handedness of a group of autistic children and found a marked departure from normality, with 65 per cent of their autistics being sinistral compared to 12 per cent of their normal children. They conclude:

> this great difference suggests that the process of normal lateralization of cerebral function fails in many autistic children. Whatever causes autism may also be responsible for a failure to lateralize ....since a high percentage of autistic children are non-right-handed, we might assume they have failed to develop the usual left hemisphere dominance (for speech)....failure to lateralize in the normal way is a clinical indicator of brain damage. Our results add to the now strong evidence that autism results from some type of selective brain damage in early life (pg. 8-9).

This finding is of interest in its implication for the etiology of autism since Satz (1973) outlines a relationship between sinistrality and early brain insult. Similarly, Barry and James (1978), in their study of autistic children, speculated that autism could be associated not only with intrauterine infections such as rubella, but also with many other specific early brain insults. Sank and Firschein (1979) also speculated on the connection between autism and disturbance in fetal development, brought on by various agents (viral, biochemical, genetic). They also concluded that the higher proportion of males to females diagnosed as

autistic may be caused by greater susceptibility of males to intrauterine disturbances.

Boucher (1977), in her study of hand preference in autistic children, found a slight increase in sinistrality among the autistic children in comparison to normal children. Blackstock (1978), in his review of the literature on the topic of autism, concluded that autistic children are predominantly right hemisphere processors from birth, and suffer from left hemisphere dysfunctions, which may occur during gestation or birth.

Sank and Firschein (1979), commenting on the possibility that autistic children are primarily right hemisphere orientated, stated that:

> almost one-third of all left-handed persons rely on their right hemisphere to produce their laterality preferences. This right brain lateralization may conflict with the same hemisphere's role in speech and communication. If some autistics have a dominant right brain hemisphere, it might explain some of their difficulties in communication. Similarly, the other two-thirds of left-handers with left brain....development aberrations may result in injuries to those areas in the left brain hemisphere that control right side lateralization. This may cause many potentially right hand autistics to compensate by developing left or mixed hand preference (pg. 696).

Thus, the previous literature shows a link between autism and sinistrality.

Schizophrenia

Left-handedness and ambiguity of lateral dominance have been associated with schizophrenia. A review of the available literature shows contradictory findings. Two studies found no difference in handedness between schizophrenic and normal populations (Oddy and Lobstein, 1972; Wahl, 1976)

Although the results of a study by Fleminger et al. (1977) failed to confirm the report of Wahl (1976), Wahl (1976) did report that schizophrenics were more likely to be confused about their left-right preferences. Other studies (Taylor, 1975; Dvirskii, 1976; Gur, 1977, 1978) suggested an excess of left-handers in the schizophrenic group. The hypothesis of left hemisphere dysfunction in schizophrenia has received some experimental support. Gur's (1977) investigation gave support that left hemisphere dysfunction might result in a concomitant shift in motoric lateralization and produce a relative increase in left-sidedness among schizophrenics.

Other neuropsychological evidence that the left hemisphere may not be fully operational in schizophrenics is noteworthy in light of the well documented language processing deficits associated with this disorder (Mefferd et al., 1969). Two other studies (Bolin, 1953; Fleminger et al., 1977) found an excess of right-handers amongst schizophrenics. One study (Taylor et al., 1980) found that severely and chronically ill schizophrenics are significantly more likely to be fully right-handed than the general population. Boklage's work (1977) on handedness in schizophrenic twin pairs, both monozygotic (identical) and dizygotic (fraternal) emphasized these discrepancies. Monozygotic twins are genetically identical. They began life as a single fertilized egg that divided to form two individuals at some point within the first 2 weeks after conception. Dizygotic twins, however, are no more similar genetically than ordinary siblings born at different times. They result from the simultaneous fertilization of two separate eggs by two different sperm.

When dizygotic twin pairs alone were considered, no significant difference emerged in handedness between schizophrenic and normal

twin popultions. However, among the monozygotic twin pairs discordant for handedness there was an excess of non-right-handedness. Boklage (1977) found a threefold excess in frequency of non-right-handedness among the schizophrenic monozygotic twins compared to the dizygotic twins, which also represents a highly significant concentration compared to normal monozygotic twins. This study implies an increased risk for schizophrenics among monozygotic pairs that include sinistrals.

Thus, in view of these mixed findings, it can be seen that there is confusion, but some association between sinistrality and schizophrenia does exist. Perhaps a further study of left-handedness in schizophrenia is justified.

Alcoholism

In his study of alcoholism and left-handedness, Bakan (1973) reported a high evidence of left-handedness in a group of male alcoholics (mean age of 44 years) in an alcoholic ward. He suggests that this high incidence of alcoholism among the left-handed may be a result of early brain insult caused by pregnancy and birth complications. Bakan states, "brain pathology resulting from anoxia associated with most pregnancy and birth complications, may be a precursor of alcoholism" (pg. 514).

Further information on left-handedness and alcoholism is sadly lacking.

Left-Handedness and Schooling

This section describing left-handedness and schooling is divided into the following sections: left-handedness and higher cognitive functions, language and speech, stuttering, reading disabilities, left-handed writing, and vocational maturity.

Left-Handedness and Higher Cognitive Functions

The pathological model of left-handedness holds that left-handers have suffered from very early minimal brain damage which has resulted in a shift from what would have been a right hand preference to a preference for the left hand. The pathological model leads readily to the prediction that brain damage will result in lowered ability on various tests of higher mental functions. Brain damage severe enough to induce a shift in hemispheric specialization is likely to cause other noticeable defects, such as slow motor development, poor eye coordination, and speech disorders. Several studies of mentally defective children have provided evidence that may be interpreted in this light.

The incidence of left-handedness has been reported to be greater among mental defectives than among intellectually normal persons. In his study of defective children as compared with normals, Gordon (1920) observed an excess of left-handedness (18.2 per cent against 7.3 per cent). According to Hecaen and De Ajuriaguerra (1964), in their study of retarded children, Karlin and Strazzulla found 16 per cent to be left-handed and Lewold found 20 per cent. In a study of 5,000 London (England) children, Burt (1969) found the incidence of left-handedness to be 4.8 per cent among normal children, 7.8 per cent among the backward, and 11.9 per cent among the retarded. Hildreth (1949) found that left-handedness exists approximately twice as much in the markedly retarded than in normal subjects. Mintz (1947) reported left-handedness in about 25 per cent of a group of moderately and mildly retarded boys - their ages ranged from 7 years to 17 years; their Stanford Binet I.Q.'s ranged from 47-87. Murphy (1962), in a study of 96 mentally retarded male children, found 23 per cent were

left-handed, with another 10 per cent being ambidextrous.

Hicks and Barton (1975) found that the frequency of left-handedness increases directly with the degree of retardation - 13 per cent of mildly and moderately retarded patients were left-handed, and 28 per cent of severely and profoundly retarded patients were left-handed.

Left-handedness is associated with epilepsy (Bolin, 1953). Morley (1972) reported an increased frequency of left- and mixed-handedness among subjects who exhibited stammering, dysarthria, cerebral palsy, developmental aphasia, articulating apraxia, and reading delay. McRae, Branch, and Milner (1968) noted that in a population of 140 epileptic patients, 75 were left-handed or ambidextrous (54 per cent).

Briggs, Nebes, and Kinsbourne (1976) studied 342 undergraduate university students in an introductory psychology course. The students were given the complete WAIS and a series of cognitive factor tests. Results showed that left- and mixed-handed individuals to have a significantly lower full scale I.Q. than right-handers. There was no difference between the mixed- and left-handers. Subjects with a positive family history of sinistrality had a lower full scale I.Q. than did subjects without left-handed relatives.

Gilbert (1973) found that the strongly left-handed do less well on a college entrance examination. A questionnaire study (Orme, 1970) reported left-handed girls in a juvenile detention home to be more unstable than right-handed ones. In her study of male juvenile delinquents (mean age 17 years), Fitzhugh (1973) found the level of sinistrality to be 32 per cent. Further, left-handed delinquents had a lower mean performance I.Q. than the right-handed delinquents.

Jones (1967), in her study of students in full-time attendance in day sessions at Los Angeles City College, found that in comparison to the general population, a significantly large proportion (52 per cent) of probationary students were left-handed or demonstrated mixed dominance. These academic probationary students had:

1) a mean score of 22 points lower than non-probationary students,
2) had severe difficulty in integrating body movement and maintaining posture,
3) had major eye sight and vision problems,
4) on projective tests showed impulsivity, depression, and extreme immaturity.

Bernstein et al. (1974) reported ambidexterity or left-handedness in increased numbers among individuals with learning problems. Zangwill (1960) described 20 youngsters with specific educational disability of whom 12 had "some left hand tendency" or were sinistral, and eight were dextral. Ingram (1960) associated delayed development of handedness with speech delay in children, and Harris (1957) observed a higher proportion of "mixed handedness patterns" in a dyslexic group as compared with a control group.

Hanvik and Kaste (1973) found in their study:

1) there are more children with mixed hand dominance in a child guidance sample than in public school sample,
2) that, in a public school sample, children with mixed hand dominance more frequently show evidence of behavioral problems, and personal maladjustment problems than those with fixed hand preference.

Blai (1971) found that mixed dominance among the left-hander was reliably associated with academic learning problems and conflicts. Several other authors have studied the relationship between learning problems and a child's ability to identify right and left. Hansen (1963) describes right-left confusion in 27 of 74 ten year old children with cerebral palsy and I.Q. over 80. Benton and Kemble (1960) noted minor abnormalities in right-left awareness in 8 to 10 year old children with normal intelligence and specific reading disability. Sparrow and Satz (1970) studied 9 to 12 year old youngsters with reading problems and demonstrated a confusion in left-right awareness among poor readers. McCormick (1978) studied the available literature on the subject and concluded that children with poor left-right orientation show greater cerebral deficits such as mental retardation and reading disability.

Some studies have found individuals who prefer their left hand, or who have no specific hand preference, to perform less well than right-handers, both on tests of general intelligence (Wilson and Donlan, 1931; Berman, 1971) and on tasks requiring certain perceptual and motor skills (James, Mefferd, and Wieland, 1967; Nebes, 1971; Nebes and Briggs, 1974).

Other studies have looked at cognitive differences between right- and left-handers. James, Mefferd, and Wieland (1967) found dextrals to be superior to sinistrals on tests of Closure Speed and Closure Flexibility. On discrimination of the left- and right-sidedness of body parts, Silverman, Adenai, and McGough (1966) showed left-handers to be inferior to right-handers.

In his study of 453 four year old subjects, Flick (1966) found that left-handed and those with mixed preference performed significantly poorer on perceptual-motor and verbal intelligence tests than subjects who were right-handed.

The pathological model of left-handedness has been responsible for much of the interest in the relationship between handedness and cognitive ability. Satz's (1972, 1973) model of the pathological left- hander helps to account for the higher incidence of left-handedness among the brain damaged and mentally retarded population.

Another approach to this question has been taken by Levy (1969). She noted that many left-handers showed evidence of some language ability in the right hemisphere, in addition to language ability in the left hemisphere. In right-handers, language skills are represented predominantly in the left hemisphere, visuo-spatial in the right. Approximately 99 per cent of right-handed people use their right hemisphere for visuo-spatial tasks, and their left for language (Branch, Milner, and Rasmussen, 1964; Rossi and Rosandini, 1967; Harris, 1975; Rasmussen and Milner, 1977; Restak, 1980; Blakeslee, 1983). For left-handers the situation is reversed about 44 per cent of the time. In practical terms, this means that almost half of any population of left-handers will perceive the world in a significantly different way than the majority of right-handers.

The two hemispheres differ in their basic approach to data processing, the left tending to analyze stimuli sequentially and linerally for nameable details, while the right is more concerned with synthesizing a concept of the overall configuration in a holistic, gestalt manner (Bogen, 1969; Nebes, 1974). This may help to explain the difficulties encountered in arriving at a general agreement as to the value of a

work of art. Starting with the Greeks, attempts have been made to place aesthetics on a scientific basis. Why shouldn't people agree on the value of a work of art as easily as, say, the correctness of an algebraic equation? Part of the differences may stem from differences in cerebral lateralization, and hence effects as person's cognitive profile. Differences in cerebral lateralization effect the way people thank and perceive the world about them. If almost half of the left-handed population has reversed cerebral lateralization from the right-handers, then differences regarding aesthetics can be expected.

Levy (1969) noted that many left-handers show evidence of some language ability in the right hemisphere as well as some language ability in the left hemisphere. From the results of unilateral brain injury (Goodglass and Quadfasel, 1954), unilateral hemispheric anaesthetization (Branch, Milner, and Rasmussen, 1964), and paroxysmal dysphasia (Hecaen and Piercy, 1956), it was shown that left- and mixed-handed individuals are more likely to have some language representation in both cerebral hemispheres than are right-handers. Levy (1969) suggested that the differences between the two hemispheres evolved because of a fundamental incompatibility between the two modes of data processing - the verbal versus the visuo-spatial. She proposed that individuals in whom verbal and visuo-spatial abilities are carried out within the same hemisphere would then be deficient in one or the other other of process when compared to more completely lateralized individuals. Since our society stresses language and verbal development, the nonverbal development would suffer. Thus, she predicted that left-handers should do more poorly than right-handers on visuo-spatial tasks, but perform similarly on verbal tasks.

To test her hypothesis, she administered the Wechsler Adult Intelligence Scale (WAIS) to 10 left-handed and 15 right-handed graduate students from the California Institute of Technology. The WAIS can be broken down into two parts, a verbal and a performance component. Thus, in terms of the WAIS subscales, Levy predicted that right- and left-handers would have an equally high verbal I.Q. but that the performance I.Q. of left-handers would be significantly lower than that of right-handers. This prediction was confirmed in her sample. Thus, Levy's prediction of a deficit in visuo-spatial abilities among left-handers was borne out.

It should be noted, however, that this "deficit" is a relative one. Levy's subjects, both left-handers and right-handers, were college graduate students who showed markedly superior scores in both parts of the WAIS compared to the overall general population.

There have been attempts at replication. One study (Miller, 1971), using a larger number of subjects from a college population, obtained similar results and thus confirmed Levy's findings. McGlone and Davidson (1973), in their study of 48 secondary school students (mean age: 16.8 years) and 68 university students (mean age 20.2 years) also supported Levy. More support for Levy came from Yen (1975) and McGee (1976).

There has been some criticism of Levy's results (Briggs, Nebes, and Kinsbourne, 1976), but that objection, however, cannot explain that replication has been successful (Miller, 1971; McGlone and Davidson, 1973; Yen, 1975; McGee, 1976).

Thus, it may be concluded that real cognitive differences do exist between right- and left-handers and probably reflects underlying differences in the asymmetrical organization of function within the

brain. It appears that the data indicating that left-handedness is associated with cognitive deficits of various kinds is compelling, but there is still a great deal of controversy and inconsistency in the studies about the relation of left-handedness and cognitive ability. Annett and Turner (1974) and Annett (1970) offer a somewhat reasonable explanation for the inconsistent results. They found that cognitive abilities are somewhat similarly distributed in unselected individuals across handedness groups. However, they found an increased frequency of left-handers at the very lowest end of the ability distribution. They suggested that researchers using unselected subjects will not typically find handedness differences in abilities, whereas those investigations who study problem samples (eg: mental retardates, dyslexics, reading disabilities) will typically find left-handers over represented in their samples. This argument supports Satz's (1972, 1973) position that some left-handedness is pathological, rather than the theory of Bakan et al. (1973) which holds that all left-handedness is pathological.

Language and Speech

Taking the studies of language disablities into account, it appears that sinistrality is living up to its bad name. According to Hecaen and De Ajuriaguerra (1964), Clement Launay found 25 left-handed people among 60 cases with language retardation as against seven out of 60 in a control group; and similarly, Schneeberger d'Ataide (1951) found a larger number of left-handed (or poorly lateralized) persons in a popu-laton with language difficulties, than in a normal population. Kovarsky's (1947) study found that most vocal disorders occur in left-handed people.

Approximately 99 per cent of right-handed people use their right hemisphere for visuo-spatial tasks and have their language and speech centre located in their left hemisphere (Branch, Milner, and Rasmussen, 1964; Rossi and Rosandini, 1967; Harris, 1975; Rasmussen and Milner, 1977; Restak, 1980; Blakeslee, 1983). Approximately 56 per cent of the left-handers show the same pattern (Restak, 1980). Of the remaining 44 per cent, a study by Rasmussen and Milner (1977) showed that approximately half had right hemisphere control of speech and the remaining half had speech bilaterally in both hemispheres. From these figures one might conclude that the majority of left-handers are just like right-handers, while many of the others show a simple reversal of the pattern found in right-handers. However, clinical data suggests the picture is complex.

Branch, Milner, and Rasmussen (1964), using the intracarotid Sodium Amytal test of speech developed by Wada (1949) and sub-sequently improved (Wada and Rasmussen, 1960), studied 119 subjects who were in-patients at the Montreal Neurological Institute suffering from focal cerebral seizures. By a series of tests, it was determined 51

were left-handed, 20 ambidextrous, and 48 were right-handed. By grouping the left-handed and ambidextrous together, it was found that 48 per cent had speech on the left, 38 per cent had speech on the right, and 14 per cent were bilateral. Of the right-handers, 90 per cent had speech on the left and the remaining 10 per cent had speech on the right. There were no right-handers with bilateral representation. In the same study, Branch, Milner, and Rasmussen further studied those left-handed and ambidextrous subjects who were known to have had some damage to the left hemisphere dating from birth or the first 5 years of life. Of these subjects, a much different picture emerges. These subjects showed a much higher incidence of right hemisphere or bilateral speech. Of the 27 left-handed or ambidextrous subjects with the early left-sided brain damage, 22 per cent had speech on the left, 67 per cent had speech on the right, and 11 per cent had bilateral representation of speech. Perhaps what is striking here, is that despite the early left-sided brain damage, 22 per cent of the subjects still have speech in the left hemisphere. In the remaining 44 left-handed and ambidextrous subjects without signs of early brain damage to the left cerebral hemisphere, 64 per cent had speech on the left, 20 per cent had speech on the right, and 16 per cent had bilateral representation. Branch, Milner, and Rasmussen felt these pecentages were representative of a normal population of left-handers. They concluded that "handedness is a relevant factor in predicting the side of representation of speech".

McRae, Branch, and Milner (1968), in their study of 140 epileptic patients using Sodium Amytal testing for language dominance, revealed that 34 (23 per cent) had right hemisphere speech and nine (6 per cent) had bilateral speech. Subsequently, Rasmussen and Milner (1975)

reported on 140 right-handers and 112 left-handers. None of the right-handers had bilateral speech representation, 96 per cent had left hemisphere dominance for speech, and 4 per cent had right hemisphere dominance for speech. Of the left-handers, 70 per cent had left hemisphere, 15 per cent had right hemisphere, and 15 per cent had bilateral speech representation.

Strokes generally happen to people who are over 40 and, therefore, fully developed mentally (Blakeslee, 1983, pg. 137). A stroke generally involves a stoppage of the blood supply and, hence, oxygen starvation to part of the brain which results in damage to the affected region. When brain cells are deprived of blood circulation for more than a few minutes, they are damaged irreparably. Because blood is supplied to each hemisphere separately, strokes usually affect only one-half of the brain. Since each half controls the opposite side of the body, paralyses of the right side indicates a stroke in the left hemisphere and left-sided paralysis indicates a stroke in the right hemisphere.

Strokes that numb or paralyze the right side of the body are very serious. Since they result from left hemisphere damage, they generally cause partial or complete loss of normal speech called aphasia. The term is from the Greek word "phasio", for utterance, so with the prefix "a", it means "wthout speech". Since the brain tissue does not heal, only limited improvement due to brain reorganization is possible. The prognosis for recovery from aphasia following a stroke is much better in left-handers than in right-handers (Hecaen and De Ajuriaguerra, 1964; Zangwill, 1967; Hecaen and Sauguet, 1971; Bradshaw and Taylor, 1979). Also, dextral aphasics with sinistral close relatives tend to have a better prognosis for recovery than dextrals with non-sinistral

relatives (Hecaen and Sauget, 1971; Luria, 1979).

Several investigators believe that recovery from damage to the speech hemisphere is a function of the extent to which the remaining undamaged hemisphere can take over. However, the brain organzation of left-handers appears to be more complex than right-handers. Left-handers with speech controlled predominantly by one hemisphere may have the other hemisphere available "in reserve" to a much greater extent than right-handers. Much evidence points to a greater bilaterality for the language function in left-handers.

Goodglass and Quadfasel (1954) showed that, as a group, left-handers tend to be less well lateralized in their language functions than right-handers, as suggested by the substantially higher percentage of left-handers who showed aphasic symptoms after either left or right hemisphere injury.

Luria (1969) showed that recovery from aphasia is faster and more complete among familial than among nonfamilial left-handers. He suggested that familial left-handers show the greater degree of bilaterality between the hemispheres.

Approximately 98 per cent of the right-handed dysphasics have left hemisphere brain damage (Hicks and Kinsbourne, 1978), whereas dysphasia in a right-hander following unilateral trauma to the right hemisphere is very rare (less than 2 per cent). In left-handers, dysphasia following a right hemisphere lesion appears in approximately one-third of those affected (Gloning et al., 1969; Hecaen and Sauget, 1971).

Unilateral electronconvulsive therapy has been employed to study hemisphere asymmetry. Left hemisphere application of electron-convulsive therapy in right-handers leads to a much greater impairment

on a verbal task than if the same treatment is applied to the right side (Fleminger et al., 1970; Pratt, Warrington, and Halliday, 1971; Pratt and Warrington, 1972). Warrington and Pratt (1973) found seven of 30 (23 per cent) left-handers were more dysphasic after right hemisphere electroconvulsive therapy, compared with one of 52 (2 per cent) right-handers (Pratt and Warrington, 1972). No asymmetry was found in two of the 30 (7 per cent) left-handers, whereas all 52 right-handers showed asymmetry.

Hecaen and Perry (1956) concluded that left-handers vary more than right-handers, not only in which hemisphere is dominant for speech, but also in the diffuseness of language representation within a single hemisphere.

Hecaen and De Ajuriaguerra (1964), after a review of the available literature, concluded that the language function if the left-handed is bilateral; and that the language function in the Left-handed is organized in a more diffuse way in a single hemisphere than in the right-handed.

Hardyck and Petrinovich's (1977) literature review concluded that the left-handed have a more bilateral functional organization, both verbally and visually, than do the great majority of the right-handed.

Similarly, Hicks and Kinsbourne (1978), in their review of language, laterality, and handedness, concluded that:

> left-handers are more variable than right-handers concerning which hemisphere is superior for language functions and in regards to consistency of lateralization for language within and between the hemispheres (pg. 527).

On other measure of lateralization, such as dichotic listening tests, manual performance tests, conjugate eye movements during mental problem solving, and tachistoscopic studies in which the performance

of left-handers and right-handers are compared, the left-handers show weaker lateralization than right-handers (Bryden, 1965; Satz et al., 1965 Kinsbourne,1972; McGlone and Davidson, 1973;Gur, Gur, and Harris, 1975; McKeever and Van Deventer, 1977; Hicks and Kinsbourne, 1978). Thus, in general, left-handers show smaller asymmetries than dextrals.

A rare instance in which left-handers are more strongly lateralized than right-handers has been reported by Froeschels (1961). Tongue clicking is usually done to the side of the mouth ipsilateral to the preferred hand, and this relationship is more consistant for left-handers.

There is evidence which suggests that some of the variability between the left-handers may be accounted for by determining whether a left-hander has first degree relatives (parents, siblings, or children) who are themselves left-handed. There is, however, dispute in the available clinical literature as to whether bilateral speech representation is stronger with familial sinistrals (left-handers in the immediate family), or with nonfamilial sinistrals who have purely dextral close relatives (Warrington and Pratt, 1973; Newcombe and Ratcliffe, 1973). Dichotic listening tests by Kimura (1961) have shown that those with left hemisphere speech centers typically show a right ear disadvantage, those with right hemisphere speech show a left ear advantage. In one study (Zurif and Bryden, 1969), using dichotic listening, left-handers without a history of familial sinistrality showed a right ear superiority and familial left-handers showed no left-right difference. Other studies have found that the left-hander with left-handed relatives showed the largest right sided asymmetry, and the left-hander without left-handed relatives showed signs of bilateral or right hemisphere speech

(McKeever and Van Deventer, 1972). Other researchers have reported no difference in asymmetry between familial and nonfamilial left-handers (Bryden, 1973; Hines and Satz, 1974). Other claim that only familial sinistrals have a bilateral language representation (Hines and Satz, 1971; Lishman and McKeekan, 1977), while others claim the opposite, that it is the nonfamilial sinistrals who are more bilateral (Higginbottam, 1973; McKeever and Van Deventer, 1972a, 1977b). Thus, there is much confusion and the topic could be studied further.

Stuttering

Another fairly common language problem related to lateralization and handedness is stuttering. About 10 per cent of all children stutter at some stage of their development (Wingage, 1976). In the majority of cases the stuttering clears up naturally in less than a year - probably because of continued development of lateralization (Blakeslee, 1980).

Sirkowski, in 1891, was the first to draw attention to the relation existing between left-handedness and stammering (Hecaen and De Ajuriaguerra, 1964).

Most people have probably heard that it is unwise for parents or teachers to try to force a child showing a natural preference for the left hand to use the right hand. It has been argued that such attempts will potentially increase the chances that the child will stutter. It was probably Inman who first related stuttering to thwarted left-handedness (Hecaen and De Ajuriaguerra, 1964).

Samuel Orton (1927, 1929) played an important role in establishing this idea. Orton believed that stuttering, in some cases, is the result of competition between the hemispheres for the control of speech. In individuals with cerebral dominance well established, the left hemisphere

assumed control, whereas those with poorly established or mixed dominance were at risk for stuttering. Forcing a child to switch hands against his or her natural preference could disrupt the establishment of dominance and result in a stuttering problem. In his own practice with stutterers, Orton observed that children, allowed to use their naturally preferred left hand after having been forced to use the right hand, would stop stuttering. One study found that about one-half of all stutterers were left-handed people who had been forced to use their right hand (Hecaen and De Ajuriaguerra, 1964). However, this is not to say that forcing a shift in the writing hand will cause stuttering in adults. Because of the complexity of hemisperic specialization, certain patterns of brain organization may, at critical stages of development, be particularly vulnerable to changes in handedness. Some experiments have tried, in failure, to induce stuttering in adults by forcing shifts in the writing hand. They also tried to cure stuttering in the same way. Herron (1967) mentions the doctor who put a stutterer's right hand in a cast for months to improve his speech. The stutterer showed no improvement and gave up the treatment when he lost a fat trout while fly fishing.

Research by Travis and Lindsley (1933) found that 43 per cent of stutterers were originally left-handed. Bryngelson (1935), in his study of 700 clinical stuttering individuals, found 74 per cent or 519 cases were thwarted left-handed individuals. In addition, of the 519 cases, approximately 50 per cent had reading, spelling, writing, or articulatory disabilities in addition to the stuttering which they manifested. The reading disability was the most prevalent (29 per cent). Ohlendorf (1982) maintains that left-handers are at least twice as likely as right-handers to suffer from stuttering and learning problems.

Byngelson (1935) found four times (61 per cent) as many ambi-dextrous people among his stuttering group as compared to his non-stuttering group. Julian De Ajuriguerra found mixed handedness in 51 per cent of his stutterers, but only 21 per cent in his non-stutterers (Herron, 1976). Both stuttering and dyslexia occur more often in people who have mixed dominance (Keeney and Keeney, 1968). Experimental evidence on the lateralization of stutterers shows that they do not have a well-defined left hemisphere dominance for language (Blakeslee, 1980). In one experiment (Moore, 1976), stutterers read words more accurately in the left visual field while normal controls showed the normal preference for words in the right visual field.

The hypothesis that stutterers have conflicting or mixed cerebral dominance for speech has received some attention in several studies. Jones (1966) injected Sodium Amytal into both the left and right carotid arteries (Wada and Rasmussen, 1960) of four patients who had stuttered severely since childhood. In all four cases, the Wada test indicated that speech was controlled by both hemispheres. Three out of the four were left-handed. In all four patients stuttering was apparently caused by a brain organization with speech on both sides of the brain. All these patients subsequently underwent surgery removing cortex from the speech areas in one or the other hemispheres. After surgery, the subjects no longer stuttered and Sodium Amytal studies showed speech to be organized only in the unoperated hemisphere. Jones postulated that stuttering in these patients was a result of competition between the language centres located in both hemispheres.

Listening to the hesitant speech of a stutterer, it is easy to imagine two separate sources of speech fighting for control. A similar situation occurs when two people try to pass through a narrow doorway

at the same moment. They often go through several cycles of starting and stopping ("after you", "no, after you") before they finally resolve the conflict. A later investigation (Andrews et al., 1972) with three out of four left-handed stutterers failed to replicate the bilateral speech findings of Jones (1966). The fourth stutterer, who had sustained brain damage to the left termporal lobe, was shown by the Wada test to have bilateral cerebral representation for speech. Another similar investigation (Luessenhop et al., 1973), using three right-handed stutterers, failed to replicate the bilateral theory of Jones (1966).

Sussman and MacNeilage (1975a, b), using dichotic listening tests, which are designed to test hemispheric specialization for speech production, found that a greater proportion of stutterers showed a left ear advantage, while greater proportions of non-stuttering controls showed a right ear advantage. They suggested that this showed, that as a population, the stutterers have less distinct lateralization of speech than do non- stutterers, but stressed that it cannot be said that all stutterers have minimal lateralization, as a mixed dominance theory of stuttering would require (Orton, 1929; Travis, 1931).

A number of other investigations (Curry and Gregory, 1969; Perrin and Eisenson, 1970; Sommers, Brady, and Moore, 1975) have explored hemispheric processing in stutterers employing verbal dichotic tasks. Results of these investigations have demonstrated the reduction, absence, or reversal of the right ear advantage which shows left hemisphere processing for speech perception. Curry and Gregory (1969) found that 55 per cent of adult stutterers had a left ear advantage in a dichotic task, while only 25 per cent of non-stutterers showed a left ear advantage. A study by Quinn (1972), utilizing a dichotic word test showed that a large majority of stutterers showed evidence of reversed

dominance.

However, it should be pointed out that other investigations have not upheld these results (Cerf and Prins, 1974) and have demonstrated a right ear advantage for stutterers under verbal dichotic tests. A possible explanation for these divergent findings may reside in the varying dichotic verbal stimuli (e.g., syllables, digits, words) and the response tasks (e.g., single response mode, multiple response mode) employed in each of the investigations. In the investigations that failed to demonstrate a right ear advantage or a reduced directional ear effect (Curry and Gregory, 1969; Perrin and Eisenson, 1970; Quinn, 1972; Sommers, Brady, and Moore, 1975) meaningful linguistic stimuli, rather than syllables were employed.

Other studies have investigated visual hemispheric specialization in stutterers. An early study (Jasper, 1932) investigated the phi phenomenon in right-handed, left-handed, and ambidextrous stuttering subjects. Results of the study indicated that the stutterers lacked cerebral dominance for this visual task.

Recent investigations (McKeever and Huling, 1971a, b; Hines, 1972; McKeever et al., 1972; Moore and Weidner, 1974) have demonstrated a preference in the right visual half-field of non-stutterers for meaningful words under bilateral tachistoscopic presentation. Such studies have revealed that a significantly larger porportion of stutterers, compared to non-stutterers, obtained a left visual half-field percentage score greater than 50 per cent. Indeed, 53.3 per cent of the stuttering subjects actually had higher left visual half-field scores, a finding which is quite similar to 55 per cent of stutterers found to have a higher left ear score by Curry and Gregory (1969). Other investigations have reported larger percentages of their stutterers

having reversed dominance for dichotic tasks (Perrin and Eisenson, 1970; Prins and Walton, 1971; Quinn, 1972; Sommers, Brady, and Moore, 1975). This consistency among investigations, for larger percentages of stutterers demonstrating a reversed ear effect, together with findings that a significantly large proportion of stutterers obtain a high left visual half-field effect indicates that a large incidence of stutterers are right hemisphere dominant individuals. In comparison to non-stutterers, stutterers appear to have a reversed cerebral dominance. However, this author would agree with Quinn (1972) that the significance of "reversed dominance" in many stuttering individuals is quite unclear.

Evidence presented suggests that there is a higher incidence of left-handedness and ambilaterality among stutterers than in the general non-stuttering population. Since left-handers and ambidextrous people tend to be less lateralized for language functions than right-handers, the increased incidence of left-handedness and ambilaterality among stutterers is not overly surprising. However, the status of the relationship between hemispheric organization and stuttering should not rest solely on handedness data. Evidence from studies have shown that many right-handed stutterers perform in a manner similar to many left-handed non-stutterers on dichotic tasks (Zurif and Bryden, 1969; Bryden, 1975) and tachistoscopic tasks (Bryden, 1964; White, 1969).

Perhaps stuttering is a disorder with many possible causes, only one of which may be related to brain organization. Differences in subject populations could be a major factor in failures to replicate results. Until we are able to identify specific subgroups, the replication problem will persist.

What of the claim that forcing a child to switch hands increases

the likelihood the child will stutter? Although the case for brain asymmetry in stuttering is not as strong as that for its role in reading disability, at this point we know that brain lateralization and stuttering are related. The switching of hand usage at an early age may have important consequences for the distribution of language functions between the hemispheres. However, there may well be a link between stuttering and forced switching that is independent of brain lateralization. A general increase in stress may be caused by insistence that the child use a hand she or he is not comfortable with. This stress, in turn, may be the factor that is related to stuttering. This would argue against the neurolgoical basis for the link between hand switching and stuttering and would suggest that any association is the result of processes of a different sort.

Reading Disabilities

Samuel T. Orton (1937) was one of the first investigators to propose that reading disabilities were linked with inadequate patterns of cerebral dominance. He felt that many poor readers showed disturbances of laterality. Orton observed that children who made mirror image reversals in reading and writing also tended to have unstable preferences for one hand. Orton claimed that 69 of his 102 cases were ambidextrous or came from families with some history of mixed or left-handedness. Harris (1957) also found that a high proportion of young disabled readers showed mixed hand preferences.

Other authors have reported a high incidence of left-handedness among disabled readers (Dearborn, 1933; Wall, 1945, 1946; Zangwill, 1962; Wussler and Barclay, 1970; Zurif and Carson, 1970); whereas other studies (Gates and Bond, 1936; Jackson, 1944; Chakrabarti and

Barker, 1966; Applebee, 1971; Hartlage and Green, 1971) were unable to conclude that there was a clear cut association between reading disability and handedness. After a review of the available literature, Vernon (1960) was unable to conclude that there was any clear association between reading disability and handedness, but as Corballis and Beale (1976) state, "unfortunately studies of the relation between reading backwardness and handedness are complicated by difficulties, and inadequacies in the measurement of handedness" (pg. 169). However, handedness still merits study because of the occasional investigation showing definite relationships between handedness and other pertinent criteria (Harris, 1957; Meuhl, 1963; Kaufman, Zalma, and Kaufman, 1978).

Reading disability may be linked to a failure to establish cerebral lateral dominance. Zangwill (1960) presented evidence which showed that poor readers have weak, mixed, or inconsistent hand preferences, and show inconsistencies as far as hand, eye, and foot preferences are concerned.

Do the left-handers show more mixed or indeterminate dominance than dextrals? Accordingly, several studies have strongly suggested this is the case (Isom, 1967; Blau, 1974; Corballis and Beale, 1976; Hicks and Kinsbourne, 1978).

Klisz and Parsons (1975) tested left-handers with musical tones. Musical tones are normally dealt with by the right hemisphere. Ten out 16 (62.5 per cent) showed left ear preference, indicating the same lateralization as right-handers. The remaining six subjects (37.5 per cent) who showed right ear preference, had a greater tendency of mixed hand preferences and showed evidence of mixed laterality. With Sodium Amytal, a single hemisphere can be anaesthesized, leaving

the other alert. Sodium Amytal studies have shown that about 44 per cent of left-handers do not have the same internal lateralization as right-handers.

Dyslextics are often unable to see the difference between words such as "pot" and "top" or letters such as "d" or "b". Tests consistently show that dyslextics have a different pattern of lateralization than normal readers (Blakeslee, 1980).

Ingram and Reid (1956) found that only 29 per cent of poor readers, in a group of children with development dyslexia, were strongly lateralized. Mackworth (1976) found that dyslextics are often poorly lateralized, and may have problems with left-right orientation.

Other studies (McFie, 1952; Curry and Gregory, 1969; Bryden, 1970; Zurif and Carson, 1970; Witelson and Rabinovitch, 1972; Bakker et al., 1973, Thomson, 1976; Witelson, 1977) have indicated that dyslextics are less lateralized than normal readers.

Sank and Firschein (1979) reported relatively high frequency of mixed handedness in children with reading disabilities. The incidence of mixed handedness was 70 per cent for children aged 7 years; 42.7 per cent for 9 year olds; and 34.6 per cent for children 11 years and older.

According to Hecaen and De Ajuriaguerra (1964) the following - Orton, (1937) Skysgaard (1942), and Eritis (1947) - reported that left-handedness is more common in those with dyslexia (pg. 80). Dearborn (1931) found a higher percentage (29 per cent) of left-handed individuals among those with dyslexia.

Accordingly, Hecaen and De Ajuriaguerra (1964) reported that Roundinesco, Trelat, and Trelat (1948) found 50 per cent of their dyslextic group were left-handed. Mackworth (1976) noted that

Beaumont (1974) found the extent of left-handedness is not related to reading difficulties, but that people with right or mixed dominance (generally the left-handed) are less lateralized than those with left brain dominance (generally the right-handed).

Reading disabled people are more likely to be found in subjects with an interminate or mixed dominance (Benton and Kemble, 1960; Sparrow and Satz, 1970).Gur et al. (1982) found that left-handers have weaker hemispheric cognitive specialization.

Lomas and Kimura (1976) found that concurrent manual activity (rhythmic tapping) with the right hand interfered with speech in right-handed subjects but that left hand activity had no effect on speech. However, left-handed subjects showed equal interference with speech activity when tapping with either hand, indicating a more bilateral or mixed dominance in the left-handers. In general, cerebral lateralization is less complete in the left-handed (Herron, 1976; Bradshaw and Taylor, 1979).

In their research of the available evidence on handedness and cerebral dominance, Hardyck and Petrinovich (1977) concluded:

> when these studies are examined for common trends, the variability shown by the left-hander is striking. The right-handed groups display a clean-cut pattern of function in most cases. The left-handed are sometimes identical in performance with the right-handed, but more often than not, show smaller interhemisphere differences....the left-handed have a more bilateral functional organ-ization, both verbally and visually, than do the great majority of the right-handed (pg. 396-397).

The relaton between handedness and brain dominance is no means one to one. Most left-handers have speech centered in the left hemis-phere, just like most right-handers. Some left-handers and people

with mixed dominance may have speech centers in both hemispheres. Since the non-right hander often has speech localized in both hemispheres, there may be interference with the proper functions of the right hemisphere (Mackworth, 1976). Thus, many left-handers may perform poorly on the Wechsler Adult Intelligence Scale (WAIS) performance skills (Levy, 1969). Wittrock (1975) found that poor readers had very poor verbal recall scores even when they used imagery, achieving only 20 per cent success, as compared to the 70 per cent recall of the normal children. Paivio (1971) showed that imagery is the most important variable in verbal recall. Bilateral speech representation may interfere with the imaging skills of the right brain (Mackworth, 1976), and may cause some reading disability.

Levy (1974) suggested that reading in the adult may be a right hemisphere function. In the case of dyslexia, it has been suggested that there may be competition between the right and left hemispheres, which results in the failure of dyslextics to recognize the orientation of letters or their order within words (Mackworth, 1976).

The data presented is highly suggested of a relationship between left-handedness, mixed brain lateralization, and reading disability, including dyslexia. There are many causes of poor reading, but it is clear that unusual lateralization is an important one, especially in the worst readers (Mackworth, 1976). Some abnormal lateralization may arise from genetic factors or from brain damage before, during, or after birth.

Any interference of the normal functions of the two hemispheres will reduce reading skills. The relationship between these factors seems definite, though far from precise. Left-handedness need not be in itself a handicap to reading, nor are all cases of reading disability

related to disorders of laterality.

There is undoubtedly a considerable number of non-readers who are completely lateralized and, thus, for their disability some other cause must be sought. However, it is the contention of this thesis that some disorders of laterality can play an important part in some cases of reading disability, and that there is a definite link between the left-handers and mixed laterality, and hence, left-handedness and reading disability. The reading disability implies a faulty lateralization.

An interesting test for determining reading disability and handedness has been developed by Silver and Hagen (1967). The test consists of asking the child to extend his arms, with fingers spread, while his eyes are closed. Usually one hand tends to be slightly higher than the other. The higher hand corresponds to the hand used for writing. If the hand opposite the hand used for writing is higher, or if both hands are held at the same level, the test results is considered abnormal. Silver and Hagen found that 90 per cent of the children with a reading disability have either relative elevation of the arm opposite that used for writing or relative elevation of neither arm. Conversely, 96 per cent of the children who have an abnormal extension test have a reading disability.

Left-Handed Writing

Over the decades, controversy has raged over handedness, whether it is a natural trait or a learned habit, and whether one should be changed, in fact forced to change, from left to right hand writing positions. More females than males are right-handed writers (Annett, 1979). Many left-handers can remember the severe reprimands and punishment they have received while being forced to adopt the right

hand position. However, there has been a change of educational thought on the value of forcing a hand preference change. As Freeman (1954) states:

> we should try to find out....whether the child is much more skillful with his left hand than with his right. If he is not, he should be encouraged, but not forced, to write with his right hand. If he is strongly left-handed, he should be encouraged to write with this hand, and then be shown how to do it in the most convenient and comfortable manner ....there seems to be no good reason to prohibit the child from making this adjustment (pg. 22).

Furthermore, as Otto (1966) states:

> at the present time, we have every reason to believe that left-handedness is a natural and inherited trait of a small minority of children.... they can learn to write comfortably and well.... there is general agreement that a child who shows strong preference for left-handed writing should be permitted to use his left hand....once a child has been clearly identified as being left-handed, he may need some assurance that left-handedness is quite normal (pg. 285).

More and more teachers are allowing the child to write with his or her natural preferred hand. A definitive work on left-handed writers by Enstrom (1962) deals with the relative efficiency of various approaches to writing with the left hand.

In our society, the action of writing is from left to right. For the left-handed writer, it is a matter of literally pushing the pen from left to right, while the dextral writer lets the pen follow the movement of the hand, and can immediately see what has been written. The left-hander, in some writing positions, may actually obscure the words. It is easier to pull the pen than to push it. When the left hand holds the pen, the reverse direction is more natural. To write from the left side to the right for the left-hander involves a clumsy shove. As a result

of these factors, it has often been stated that left-handers usually make poor writers.

Comparisons of left- and right-handed subjects' handwriting performance has been made in a number of studies. Reed and Smith (1962) examined the speed and quality of work done by 10, 12, and 14 year olds using both left-handed writers and right-handed writers. No significant difference due to handedness were found on speed of writing, either on a repetitive passage or on a copied prose piece. Likewise, no significant difference in quality was noted. Groff (1963, 1964), in two studies in which he reviewed the available literature on left-handed writers vs. right-handed writers, concluded that right-handed children do not handwrite better than left-handed children in the fourth, fifth, and sixth grades. Groff (1963) also found that girls' handwriting was consistently superior to boys'. These observations are useful documentation for parents who are concerned that their left-handed child is not writing normally. It is also useful data to share with sinistrals to encourage them to work on a technique which builds their confidence and appreciation for their left-handed writing.

Lewis (1964) analyzed the ability of first graders to copy the manuscript alphabet and found that the left-handed children made more errors than right-handed children before formal instruction. However, after instruction, no significant differences were found in the total number of errors, although left-handed subjects made slightly more reversal and inversion errors.

Mirror-writing is commonly found in left-handed individuals (Hecaen and De Ajuriaguerra, 1964; Barsley, 1979). Mirror-writing refers to a written form which is seen in proper orientation when placed before a mirror. The mirror writer starts in the upper right side of

the page and writes towards the left. Each letter is formed in reverse and the letters flow in a reversed (right-to-left) direction. Critcheley (1928) described mirror writing as:

> that variety of script which runs in an opposite direction to the normal, the individual letters also reversed. The writing is, therefore, illegible until held up before a looking glass; a familiar example of mirror-writing is seen in the imprints on a blotting pad.

The mirror-writer is almost always a strongly left-handed child, just beginning to learn both reading and writing (Benson, 1970). Although mirror-writing is more common among backward left-handed children (Barsley, 1979), it is by no means always a subnormal trait. For example, both Leonardo da Vinci and Lewis Carroll were mirror-writers, and neither lacked in cognitive abilities. Leonardo da Vinci wrote with his left hand and Lewis Carroll was a stutterer. Some researchers maintain that Carroll's stuttering resulted from his thwarted left hand (Hecaen and De Ajuriaguerra, 1964). The most frequent age for mirror-writers is between 5 and 9 years of age (Barsley, 1979).

With rare exception, mirror-writing does not persist to adult life. Mirror-writing in childhood is almost, if not totally, restricted to the left-handed, and long persistence of this trait is seen only in the retarded (Benson, 1970). Some authors (Orton, 1937; Critchley, 1964) have noted that reversal of asymmetrical letters occurred commonly in dyslexic children and hypothesized that mirror reading and writing constitute a major cause of dyslexia. However, in his literature review, Benson (1970) held that mirror-writing and dyslexia are separate entities and usually occur without each other. Even if both were present in the same individual, they are still separate and distinct from each other (Weigel, 1971).

Thus, in general, writing disorders are far less common in the right-handed (Hecaen and De Ajuriaguerra, 1964; Benson, 1970). It would appear that with proper educational instruction, writing difficulties associated with the left-hander can be surmounted.

Perhaps teachers need to make special provision for left-handed writers. Croutch (1969) presents suggestions about the correct position for the body and paper for left-handed writers. The New York Manual (1960-61) notes the following:

> a left-handed child will learn to write easily, rapidly, comfortably, and legibly under suitable conditions. The teacher helps to remove some emotional pressure from the child by not making him feel that he is the cause of undue trouble to her ....if there is more than one left-handed child in the class, it is advisable to have them seated near each other (pg. 29).

Kinney (1964), Ramos (1970), and Foerster (1975) each offer specific and practical suggestions for instructing and helping the left-handed writer. Regardless of the handedness of the student, there is no substitute for careful teaching and attention to details during the early years as that children will avoid forming habits which are not conducive to legibility and fluency. Perhaps it is better to have a cooperative, enthusiastic lefty who writes legibly upside-down than to have a disgruntled, antagonistic, lethargic lefty, with a properly placed wrist, who does not choose to write at all.

Vocational Maturity

The concept of vocational maturity was an unfamiliar term during the early 1950's (Jordaan and Heyde, 1979). First defined in the mid to late 1950's (Super et al. 1957,) it was given an operational definition that was empirically based in 1960 (Super and Overstreet, 1960).

Vocational maturity was later researched by Crites (1973), Jordaan and Heyde (1979), and Super and Thompson (1979).

When one talks about vocational maturity, the concept of vocational development must be considered. The concept of vocational development leads logically to that of vocational maturity (Super, 1957). There are, according to Super's career development theory (1957), which is adapted from Buehler's theory of development (Buehler, 1933), five vocational developmental stages: growth (birth to age 15), exploratory (ages 15-24), establishment (ages 25-44), maintenance (ages 45-65), and decline (ages 65+). These developmental stages have been described as crystallization, specification, implementation, stabilization, consolidation, and deceleration. In the exploratory stage, crystallization, specification, and implementation are the significant tasks. Super, like other authors, sees vocational development as a continuous process - a process as "....essentially that of developing and implementing a self-concept" (Super, 1953). An individual's self-concept may change with time, experience, and the situations in which he lives and works. In each developmental stage, the individual encounters new problems, demands, challenges, responsibilities, and expectations. This, in turn, necessitates new choices, decision, and adjustments. Choice and adjustment are, thus, never complete but are repetitive processes (Super, 1953). The process is dynamic rather than static. It is possible that one will never reach a satisfactory resolution. That is, the individual will not succeed in matching his preferences, abilities, and personality traits with an occupation that satisfies him. Moreover, an adequate resolution now may become inadequate later.

Vocational maturity is defined by Super (1957) as:

> the degree of development, the place reached on the continuum of vocational development from exploration to decline. Vocational maturity may be thought of as vocational age, conceptually similar to mental age in early adolescence, but practically different in late adolescence and early childhood because more distinctions can be made....at those stages. Vocational maturity is the place reached on the vocational development continuum which may be described not only in terms of the gross units of behavior which constitutes the life stages, but also in terms of much smaller and more refined units of behavior manifested in coping with the developmental tasks of a given life stage....Vocational maturity is thus defined in terms of types of behavior (pg. 186).

Thus, vocational maturity may be viewed as the behavior response an individual has to emerging demands, problems, challenges, and expectations within their developmental stage.

Vocational readiness goes hand-in-hand with vocational maturity. It involves the individual's readiness to deal with the vocational tasks of his developmental stage. However, individuals do differ in their readiness to deal with these vocational developmental tasks. A task may be dealt with on about the expected time, earlier or later, and it may be dealt with effectively or poorly. An individual who has already completed a task that still occupies his peers, or who is dealing with it more effectively than they, can be judged to be more mature vocationally according to Super's formulation (1957). Vocational maturity is, thus, defined as a readiness to cope with career development tasks that are appropriate to one's stage in life.

Super and Overstreet (1960), in their investigation of the vocational maturity of grade 9 boys, correlated 28 variables which may be relevant to a measure of vocational maturity. They included intelligence, socioeconomic status, family relationships, level of aspiration,

participation in school and community activities, birth order, age, religion, etc. In their investigation of vocational maturity during the high school years, Jordaan and Heyde (1979) studied only 15 of the 28 correlates, citing several reasons for reducing the number to 15 from 28 (pg. 12). Factor analysis showed that the structure of vocational maturity in the twelfth grade is very similar to that in the ninth grade (Super and Bohn, 1970).

However, in neither study was there an attempt or effort to relate vocational maturity to left-handedness. As far as this study was able to ascertain, there has been no investigation into the relationship between handedness and vocational maturity.

The Career Development Inventory (C.D.I.) developed by Super and Associates (1981) will be used in this study to measure student vocational maturity.

CHAPTER III

METHODOLOGY

This chapter describes the subject population, the instruments used in gathering data, the collection of data, and the organizaion and treatment of data.

Subject Population

All subjects in the study were registered at Kildonan-East Regional Secondary School, Winnipeg. The school is a large one, employing 80 full-time teachers for approximately 1,350 students. It offers programs in academic courses, business education, and industrial-vocational. The school is located within the River East School Division and draws students from six participating school divisions (Fort Garry, St. Boniface, St. Vital, Seven Oaks, Transcona-Springfield, and River East) within metropolitan Winnipeg.

Kildonan-East Regional School was selected because it is large and draws students from several participating school divisions, thus representing a larger community than found in traditional secondary high schools.

Students who participated in the study were registered in either the tenth or eleventh grade on the Kildonan East Regional School card index. Students in the study came from all six of the participating

school divisions. No attempt was made to differentiate students on the basis of their place of residence. Students came from all patterns of study - academic, business education, and industrial-vocational.

The first task in this study was to determine how many left-handed writers were registered as students within the school. Approval of the school principal to carry on the study was obtained. Each tenth and eleventh grade classroom was visited, and after explaining the purpose of the visit, the question was asked, "Would all left-handed writers please identify themselves".

Left-Handed Writers

All left-handed writers in the tenth and eleventh grades were considered for participation in this study. The population of left-handed writers used in the study consisted of 60 students. There were 28 tenth grade and 32 eleventh grade students. In the tenth grade, 21 students were males and 7 females. In the eleventh grade, 19 were males and 13 females.

Right-Handed Writers

The school uses a system of registering each student on a card. Each card lists demographic information such as name, sex, grade, address, telephone number, etc. Since the left-handed writers within the school were already identified, their cards were removed from the system. The remaining cards were further divided into grade and sex. All cards listing grade twelve students were removed. The researcher then randomly selected, by going through the cards, an equivalent number of right-handed writers from the tenth and eleventh grades. To make the study as statistically valid as possible, an equal number

of right-handed males and females were selected.

A random sample of 60 right-handed writers were selected. There were 28 tenth grade and 32 eleventh grade students selected as a comparison group. The number of right-handed males and females matched the left-handed group.

Validity of Selection

As stated previously, the purpose of this study is to examine differences between secondary school left-handed and right-handed writers on selected demographic, attitudinal, and achievement variables. As a means of checking the validity of selecting the two main groups of left-handed and right-handed writers as determined by the researcher, the Harris Tests of Lateral Dominance (1974) was administered to the entire sample. If the selection was indeed valid, it would be expected that the selected right-handed writers would score high on the Harris Tests of Lateral Dominance (1974), whereas the selected left-handed writers would score low. For statistical purposes, the selected left-handed writers were given a score of 1 and the right-handed writers a score of 2. The scores obtained in the Harris Tests of Lateral Dominance (1974) and the scores given to the right-handed writers and left-handed writers were subjected to a correlation test by using the Pearson product-moment correlation coefficient. A high positive correlation would signify that the selection of the left-handed writers and the right-handed writers by the researcher was fairly valid.

The Instruments Used To Gather Data

Data were collected on demographic variables, attitudinal variables (both student self-expressed and test instrument measured), hand

dominance, career development and vocational maturity, and final marks in school subjects.

Demographic and Student Self-Expressed Attitudinal Variables

A questionnaire was designed by the researcher and administered to all students who took part in the study. The questionnaire was divided into two main sections: demographic variables and student self-expressed attitudinal variables. Demographic variables (Question 1 to Question 4) included name, sex, age, birth order, and handiness of parents and siblings. Student self-expressed attitudinal variables (Question 5 to Question 14) included participation in extra-curricular activities, attitude towards school and subjects, favorite and worst subjects, and a self-rating of student functioning in school. The questionnaire is represented in Appendix A.

Hand Dominance

Hand dominance was measured by using the Harris Tests of Lateral Dominance - 1974. The Harris Test of Lateral Dominance were first assembled in an experimental edition in 1941 and in 1947, and were published with a manual of directions and record form. After years of clinical try-out, revisions have occurred in 1955, 1958, and 1974. The determination of hand dominance will be done by the 1974 version.

The Harris Tests of Lateral Dominance - 1974 comprises a battery of tests. The battery consists of seven tests of manual dominance (knowledge of right and left, hand preferences, simultaneous writing, handwriting, tapping, dealing cards, and optionally, a dynamometer to measure strength of grip), three tests of ocular dominance (monocular sighting, binocular tests, and optional stereoscopic tests), and one

test of foot dominance (kicking and stamping).

The test has been used successfully in cases of reading and speech disabilities where lateral dominance may be a significant factor (Balow, 1963; Balow and Balow, 1964; Coleman and Deutsch, 1964; Fornes and Weil, 1970; Orlando, 1971), and has also been administered in cases of spelling, writing, and neurological difficulties (Coleman and Deutsch, 1964; McDonald, 1964; Harris, 1974).

The age range is from 7 years to adulthood. The test may be administered individually or in small groups. Since a record blank must be manually completed for each subject by the examiner, it is extremely difficult to administer to a large group of classroom proportions. The working time is unlimited.

A 30 page User's Manual (Harris, 1974) accompanies the test form. This manual gives such information as theory of lateral dominance, directions for test administration, interpretation of results, information on reliability and validity, and tables which eliminate the need for arithmetical computation in scoring and interpreting. The meaning and significance of lateral dominance is discussed also.

According to the User's Manual (Harris, 1974), most subjects enjoy the lateral dominance tests and there is rarely any difficulty in getting cooperation. Subjects often express their dissatisfaction with their performance in the Simultaneous Writing Test or in the timed hand dominance tests.

As previously stated, the Harris Tests of Lateral Dominance - 1974 comprises a battery of tests.

The following is a description of the battery of tests.

TEST 1. Knowledge of Right and Left

Here the subjects are requested by the examiner to show their right hand, left ear, and right eye. This is included in the battery of tests because many individuals who show directional confusions or reversal errors in reading and spelling have difficulty in naming right and left.

It would be expected that few high school students would be confused about identifying right and left, and so this test was excluded from our battery of tests.

Hand dominance is determined by a series of six tests. We will concern ourselves only with five of the six tests, as one of the tests (Strength of Grip) is not considered reliable enough.

TEST 2. Hand Preferences

This section consists of a series of ten subtests. The subjects are asked to show to the examiner in a pantomine how they would (1) throw a ball, (2) wind a watch, (3) hammer a nail, (4) brush their teeth, (5) comb their hair, (6) turn a door knob, (7) hold an eraser, (8) cut with scissors, (9) cut with a knife, and (10) write. This series of questions is designed to show which is the preferred hand for the ten selected activities. The use of pantomine rather than verbal answers

reduces the chance of getting stereotypes responses and improves validity.

TEST 3. Simultaneous Writing

Subjects are asked to close their eyes and then write on the record blank before them, with a pencil in both hands, numbers from one to twelve simultaneously. The numbers are to be written one below the other, and as fast as possible. The examiner is to note any reversals of the written numbers with either hand, and to record the number of reversals.

The purpose of this test is to disclose directional confusion and mixed or incomplete hand dominance. The principle employed here is that when both hands attempt to perform the same movement simultaneously, the nondominant hand tends to do it mirror-wise, reversing the left- right directions. For example, in general, the strongly left-handed make no reversals with the left hand, but often make reversals with the right hand. Strongly right-handed subjects make no reversals with the right hand, but may make up to ten reversals with their left hand. According to the manual of directions, the median number of reversals in the nondominant hand is three. The digits written with the dominant hand are much better formed than those written with the

nondominant hand. When an individual makes a reversal with his dominant hand, or reverses with both hands, the examiner can be fairly confidently certain that a real directional confusion exists.

TEST 4. Handwriting

In this test, subjects are requested to write their full name on the record blank. This is done with one hand and then with the other hand. The time taken to write with each hand is recorded in seconds. In general, subjects write twice as fast with the dominant hand in comparison to the non-dominant hand.

TEST 5. Tapping

In this section of the test, the subjects are instructed to make dots in square boxes provided on the record blank. Provision is made for a practice session. The dots are made first with one hand and then the other. There is a timed limit of 30 seconds for each hand. The tapping test is a measure of speed and coordination in finger and hand movement, using one hand. The time limit of 30 seconds for each hand is long enough to give reasonably good reliability and short enough to avoid fatigue effects.

TEST 6. Dealing Cards

Here the subjects are requested to make believe they are playing cards with another. A deck of cards is divided into two packs of 26 cards each. The subjects are to deal out the 26 cards as fast as they can, first giving one to the examiner and then one to themselves. They are to continue this procedure until they run out of the 26 cards. The time in seconds is recorded for dealing out the 26 cards. The procedure is repeated with the other hand. The hand which showed the best coordination is also noted.

The card dealing test requires coordination of both hands, in which one hand takes the leading role and the other a subordinate role. In general, the pack is held in the nondominant hand and the cards are dealt out with the dominant hand.

TEST 7. Strength of Grip (Optional)

By use of a dynamometer, this test determines the grip strength of each hand. It is recognized that this test is the poorest of the hand dominance and contributes little to lateral dominance. This was recognized by the author and for this reason, this test was readily omitted from our battery of tests.

After the five separate hand dominance tests have been rated, a total hand dominance rating is obtained from the composite ratings

of the five tests. This hand dominant rating ranges along a five point scale from strongly right- to strongly left-handed. The ratings are as follows:

SR - strongly right-handed

R - moderately right-handed

M - mixed handedness

L - moderately left-handed

SL - strongly left-handed

The total hand dominance rating is a matter of qualitative judgement rather than quantitative, and no overall numerical score is obtained. It is a matter of considering all of the evidence, and is not simply a mean or median of the separate ratings. The User's Manual (Harris, 1974) provides assistance and direction for assessing the total hand dominance rating.

Further tests are provided to determine eye dominance and foot dominance. However, for the purpose of this study, they were not relevant. We were concerned only with hand dominance and, hence, this study limited itself to that dimension.

The User's Manual (Harris, 1974) gives information on reliability and validity of the tests. Reliability data is given in terms of coefficiencies of contingency. Determining the test - retest reliability of the Harris Tests of Lateral Dominance - 1974 is no easy task. On Test 1 (Knowledge of Left and Right), a single administration probably provides enough learning experience to change the nature of performance on a retest. A further complicating factor is that the significant results are not the raw scores but the ratings derived from them. These ratings are in a five point scale and the distribution tends to be marked by skewed or "J" shaped, since most people are strongly

right handed. Hence, correlation methods which assume a normal bell shaped distribution of scores do not apply. However, approximations of reliability can be obtained by using the coefficients of contingency. On this basis, it has been possible to compute reliabilities for four of the hand dominance tests.

Reliability data is not available for Test 1. According to the User's Manual (Harris, 1974), the contingency coefficients for Test 2 is .85, and .88 for Test 3. In a study of the Harris Tests of Lateral Dominance, Lieben (1951) found coefficients of contingency to be as follows:

Test 3, .83; Test 4, .76; Test 5, .75.

According to the User's Manual (Harris, 1974), the validity of the battery of tests of lateral dominance can be determined in three ways: content validity, comparability to other similar tests, and usefulness in differentiating identified groups.

Content validity can be evaluated by considering whether the content and nature of the tasks are appropriate for the purposes for which the tests are intended. The User's Manual (Harris, 1974) says nothing about the validity of the separate tests, but assumes that they have evident face validity.

Another measure of validity is how do the Harris Tests compare favorably with other measures of the same characteristics. Evidence provided by the User's Manual (Harris, 1974) show that our hand dominance tests are reliable and valid and have discriminative measures which are more sensitive to mixed dominance and directional confusion than other similar hand dominance tests.

The third measure of validity is how useful is the test in differentiating groups known to be different in relevant characteristics. The

User's Manual (Harris, 1974) presents evidence which show that our tests have this quality. This is particularly noticeable in differentiating school children with reading disabilities from unselected school children by their performance on the hand dominance tests. In addition, eye dominance and foot dominance tests do not similarly differentiate these populations.

In summary, the Harris Tests of Lateral Dominance (1974) has been used successfully in several studies (Balow, 1963; Balow and Balow, 1964; Coleman and Deutsch, 1964; Fornes and Weil, 1970; Orlando, 1971). The tests are simple, interesting, quick, and readily administered. Directions for administering and scoring the tests and for interpretation of results are clear and complete. Data showing hand and eye dominance in random samplings of the population and in reading disability cases are listed in the manual as well as the relation between total hand dominance ratings and eye dominance ratings.

The various tests for measuring hand dominance are well chosen. The view that a composite score derived from responses in several tests is more valid than the score on a single one, is sound.

Additional data on reliability and validity should be provided by the author and publisher as it becomes available. The tests tend to be more qualitative and clinical rather than quantitative.

Attitude Towards School Subjects

Measurement of attitudes toward school subjects were determined by using the Estes Attitude Scales - Measures of Attitudes Toward School Subjects (Estes et al., 1981). The Estes Attitude Scales (EAS) is published in two forms. One is an Elementary Form which measures the attitudes of elementary school

children toward each of three school subjects: reading, mathematics, and science. The other is the Secondary Form, for grades 7 to 12, which consists of five 15 item Likert-type scales, which measures the attitudes of junior and senior high school students toward each of five subject areas: English, mathematics, reading, science, and social studies.

The Likert technique to measure attitudes was developed in 1931 by Rensis Likert and has been widely and successfully used by many others (Sax, 1980). A Likert-type scale employs five choices expressing different degrees of agreement or disagreement. On the Secondary Form, some items are worded positively (time spent in English class is time well spent) and some are worded negatively (math is boring). Positively stated items are scored on a 1-5 scale, whereas negatively worded items are scored in an inverted order of 5-1.

LIKERT SCALE	Positively Stated SCORE	Negatively Stated SCORE
Strongly Agree	5	1
Agree	4	2
Cannot Decide	3	3
Disagree	2	4
Strongly Disagree	1	5

The higher the score, the more favorable the attitude towards the school subject. Thus, those students with higher scaled scores generally do have more favorable attitudes toward the subject than those with lower scores.

The items have a readability level equivalent to the sixth grade and the content is appropriate for most students in grades 7 through

12. Each 15 item scale may be administered separately, or the entire battery may be given at one sitting. There is no time limit, but time of administration for the entire 75 item Secondary Form averages about 25 minutes. Responses are recorded on a separate answer sheet. Scoring is done by hand. It takes approximately 3 to 4 minutes to fully score each student's answer sheet.

The EAS Manual for Administration and Intepretation (Estes et al., 1981) defines attitude towards a subject as "a liking for or a dislike of a given subject in school....(a) favorable attitude is evidenced by verbal statements, by a tendency to choose and apply oneself conscientiously in subject-related activities, and by belief in the value of the subject. Avoidance behaviors indicate an unfavorable attitude toward a subject (pg. 1).

The advantage of using the EAS is that a quantitative measure of the attitudes of individuals or of groups is easily provided. In our case, a reliable measure is obtained for comparisons between left-handed and right-handed writers.

The validity of a test indicates the degree to which it measures what it is intended to measure. The User's Manual of the EAS (Estes et al., 1981) considers content validity, factorial validity, convergent validity, and discriminant validity. The most common method of validating responses on attitude scales are by content and concurrent or convergent validity (Sax, 1980).

Content validity refers to the extent to which an item measures some specified objective (ie: attitude towards a school subject) and based on the judgements of qualified experts on the subject. Content validity is very easily determined for instruments using Likert scales (Sax, 1980). Items can be rewritten and revised until raters agree

that they are clear and unambiguous. Suitable items for the Secondary From of the EAS were selected in the following manner. First, by searching verbal indicators found by previous researchers to indicate attitudes toward school subjects, and second, teachers and students were asked to provide statements which they believed would select those subjects with positive attitudes toward a school subject from those with negative attitudes. By this method, an item pool containing several hundred verbal statements was constructed. As a result of further item analyses, testing and refinement, the EAS evolved into its present form of five 15-item scales measuring attitudes toward English, mathematics, reading, science, and social studies.

Construct validity is the extent to which an instrument measures the characteristics that it claims to measure. It shows the degree to which performance on the instrument actually is associated with theoretically related characteristics or construct. The construct underlying the EAS is attitude towards school subjects. As described in the User's Manual of the EAS (Estes et al., 1981), factor analyses of the five basic content areas (English, mathematics, reading, science, and social studies) was used as a means of providing additional information for the interpretation of construct validity, and as a method of assessing the overall structure of the EAS. The result was that the scale items clustered according to the school subject (ie: English items loaded on the same factor, mathematics items on the same factor, etc.).

The factor analysis showed items loaded on a two factor structure - verbal (Factor I) and quantitative (Factor II) attitudes. The English, reading, and social studies scales load highly on Factor I in the following manner: English - .79, reading - .77, and social studies - .71. The mathematics and science scales load highly on

Factor II in this fashion: mathematics - .82, science - .79. As can be seen, the loadings are large and significant ranging from .71 to .82. The factor loadings indicate that the items of the EAS are relevant in determining attitude towards school subjects. Thus, further evidence of construct validity is provided.

To help support the test construct, evidence may be obtained from different sources. Convergent validity is shown when a test or other measure of a proposed trait positively correlates with instruments of other kinds designed to measure the same trait or that are thought to measure it (Guilford and Fruchter, 1978). There is a call for evidence of the measurement of the construct by different methods, e.g., ratings by self and by others, performance tests, etc. When different tests or criterion all measure the same construct, the construct has convergent validity (Sax, 1980). One study (Johnstone, 1973) examined the EAS for convergent validity using these six criteria - self rating of attitude, peer judgements of attitude, teacher rankings of attitude, course grades, standardized achievement scores, and extracurricular participation. The evidence obtained provided a sound case for convergent validity of the five scales of the Secondary Form. Other studies (Dulin and Chester, 1974; Luzzetti, 1974; Cramer, 1975; Summers, 1978) have given further evidence of convergent validity.

In addition to demonstrating that a test is positively correlated with validating criteria (convergent validity), it should be shown that constructs do not correlate with irrelevant factors. That is to say, the construct should have discriminant validity. Discriminant validity is demonstrated when the test correlates little or not at all with measures of other traits, whether by the same method or by other methods. For example, a test measuring conformity, or rigidity, should not correlate

highly or positively with a measure of divergent or non-linear thinking. Demonstrating what a construct does not represent is as important as showing what it does represent. The User's Manual (Estes et al., 1981) provides evidence to verify the discriminant validity of the EAS.

The search for high correlation among different methods of measuring the same trait and low correlations between measures of different traits in some ways is factorial validity. Thus, the measures of convergent validity and discriminant validity are steps to a more refined conception of factorial validity and factor loadings. The composite evidence presented in the User's Manual (Estes et al., 1981) constitutes a sound case for the convergent and discriminant validity of the Secondary Form.

A reliability coefficient is obtained by correlating scores from two alternate parallel forms of the same test. In the EAS User's Manual (Estes et al., 1981) reliability is measured in terms of alpha reliability coefficients (as developed by Cronback in 1951). The EAS was administered to two large groups of students. Sample A consisted of 629 students in grades 7 through 12 and Sample B comprised 195 students in grades 7, 8, and 9. Scores for each attitude scale for Sample A and Sample B were computed and the results are as follows:

SCALE	RELIABILITIES	
	SAMPLE A	SAMPLE B
English	.85	.76
Mathematics	.86	.84
Reading	.93	.87
Science	.98	.85
Social Studies	.91	.82

Thus, as can be seen, the reliability coefficients range in magnitude from .76 to .93, with a median of .86. Such is quite satisfactory.

The EAS User's Manual (Estes et al., 1981) also provides normative information. Normative information is determined by a comparison of student's performance in relation to some external representative group of students, called a norm group. In 1979, both forms of the EAS were standardized on a sample of 1,815 students living in five different states. Regional areas of the United States represented in this sample were the Northeast, the North Central, the South, and the West. A demographic breakdown of this nationwide sample is given in the EAS User's Manual (Estes et al., 1981) on the following basis: sex, residence, race, region of the United States, grade, and age.

A norm is an average performance on a test by a defined group (Noll and Scannell, 1972). Norms provide a means for comparing a subject with a reference group. The EAS User's Manual (Estes et al., 1981) provides normative information through the use of percentiles and T-scores. Percentile norms are widely used and relatively easy to understand. The use of T-scores has the advantage that the student's relative performance on various tests can be directly compared.

Raw scores from the EAS that convert into T-scores ranging between 40 and 60 represent an average attitude toward the school subject area. A reference table is provided in the EAS User's Manual (Estes et al., 1981) for ease of converting raw scores to T-scores.

Vocational Maturity

Voctional maturity was measured using the Career Development Inventory (CDI) (Super et al., 1979). The CDI is an instrument designed to measure career development and vocational maturity at

the secondary school and early adult level. Its publication follows research beginning in 1951 (Super et al., 1957), with the Career Pattern Study. At teacher's college, Columbia University such vocational studies as the Career Pattern Study hypothesized and defined the concept of vocational maturity and developed questionnaires and other methods for studying it, and refined the items into scales which to measure it (Super and Overstreet, 1960).

During two decades of research, the CDI underwent several revisions. In the 1960's it was a three scale instrument (CDI Form I) and by the mid 1970's (Super and Thompson, 1979) had a six scale version (CDI Form III). The current form, published in 1981, is comprised of five basic scales and three combined scales. It is a condensed version of Form III.

The CDI is an objective, multi-factor, self-administering paper and pencil inventory for the measurement of the vocational maturity of adolescent males and females. The CDI questions are deliberately written in unisex terms and thus are appropriate for both males and females. However, such is not to mask differences between males and females, but to minimize. The reading difficulty of the CDI is at and above the sixth grade and its vocabulary and content make it acceptable to junior and senior high school students. Administration is relatively easy and is self-explanatory. Scoring can be either by hand or computer. Completion of all the items is essential to scoring. The CDI may be administered to individuals or groups in one or two sessions. It is untimed, but takes approximately 65 minutes to complete. Responses are recorded on a separate answer sheet.

The following is a description of the eight scales of the CDI:

Career Planning (CP): is made up of 20 items in which the student reports the career planning in which he or she has engaged and the degree of engagement. Although some items may appear cognitive, this scale assesses attitudes and reported planfulness.

Career Exploration (CE): is also a 20 item self-report scale. Students are asked to rate sources of career information (ie: friends, relatives, school, etc.) and to rate the usefulness of the information received from each of those sources. This is also an attitudinal rather than a cognitive scale that measures the quality of exploratory attitudes.

Decision-Making (DM): consists of 20 brief sketches of people making career decisions. This scale measures the ability to apply knowledge and insight to career planning and decision making. It is more cognitive in nature than attitudinal.

World-of-Work Information (WW): comprises 20 questions which assesses career awareness and occupational knowledge. This scale is cognitive in nature and measures variables that contribute to successful career planning.

Knowledge of the Preferred Occupational Group (PO): is made up of 40 multiple choice questions that pertain to

all occupations, which are categorized into 20 groups. Students select on the answer sheet a preferred occupational group and then answer the questions with this group in mind. This scale measures the results of the in-depth exploration and should precede the choice of training or occupation. This scale is also cognitive in nature.

Career Development Attitudes (CDA): combines CP and CE to provide a more reliable measure of attitude.

Career Development - Knowledge and Skills (CDK): combines DM and WW. This combination provides a concise cognitive scale with increased reliability.

Career Orientation Total (COT): combines CP, CE, DM, and WW. COT approaches a measure of career-vocational maturity as it measures four of the five basic dimensions in Super's (1974) model of the career-vocational maturity of adolescents.

Statistical data for the CDI was first gathered in 1971 (Forrest, 1971), using two parallel samples of 200 male and female tenth graders in Genessee County, Michigan. Other subsequent studies have been conducted in Canada, Europe, South America, Asia, and other regions in the United States.

Statistical data reported in the User's Manual (Thompson et al., 1981), showed the CDI had acceptable levels of reliability and validity.

The reliability is described in terms of internal consistency, standard error of measurement, and stability.

Ideally, of course, reliability should be +1.00, but in reality, such is seldom the case. It is reasonable to assume, that decisions involving a single individual will require a much higher degree of reliability than is necessary for evaluating the behavior of groups. However, the question that is often raised is, What is the minimum reliability that is acceptable? There is no general answer to this question. In general, we have areas of generally acceptable measurements of reliability. As Noll and Scannell state,

> the best standardized tests of achievement show reliability coefficients as high as .90 or even higher. Standardized tests of intelligence commonly have reliabilities almost as good - generally .85 or higher. The reliability coefficients for.... personality tests and interest inventories are usually lower....most often in the .70's and .80's....when a test is intended only for use in studying groups, a lower reliability coefficient (around .75) may be sufficient to make fairly accurate comparisons (pg. 152).

Measures of internal consistency on the combined scales for the tenth grade ranges from .84 to .86, and for the eleventh grade, from .86 to .87. These reliability scales are clearly adequate for individual counselling and the analyses of group differences. A similar conclusion may be drawn for the individual scales of CP, CE, and WW, with the exception of DM and PO. Reliability measures for CP, CE, and WW at the tenth grade are .86, .76, and .83, respectively; and at the eleventh grade, .88, .80, and .85, respectively. The DM and PO measures are reported for the tenth grade to be .68 and .55, and for the eleventh grade, .69 and .65. It is suggested that caution should be exercised in making judgements about individual students based on DM and PO

scores. However, the values are satisfactory for analyzing group differences in research.

An alternative expression of reliability is the standard error of measurement (SEM). The SEM value can be interpreted as approximately the average error made when a measurement is made of an individual characteristic. On the combined scales the values for the standard error of measurement (SEM) for the tenth grade ranges from 6.8 to 7.3, and for the eleventh grade, 7.0 to 7.5. On the individual scales, for the tenth grade, the range is from 6.8 to 9.0, and for the eleventh grade, the range is from 6.8 to 9.3. On the DM and PO scales, for the tenth grade, the values are 10.6 and 13.3, respectively, and for the eleventh grade, 11.1 and 11.9, respectively.

A final aspect of reliability is the stability of measurement. That is, the extent to which a measurement device yields the same or nearly the same score for an individual tested on occasions separated by an interval of time. Data presented in the User's Manual of the CDI (Thompson et al., 1981) suggests that CDI scores are a stable characteristic over periods of up to 6 months.

The validity of a test indicates the degree to which it measures what it is intended to measure. The User's Manual of the CDI (Thompson et al., 1981) considers content and construct validity.

Content validity refers to the extent to which an item measures some specified objective and is based on the judgements of qualified experts on the subject. Items have content validity if they ask students to demonstrate those skills and competencies required by the objectives. Tests have content validity of the behavior and subject matter called for if the items correspond to the behavior and subject matter identified in the specific objective.

The CDI is based on the theoretical model that was developed and tested in the Career Pattern Study (Super and Overstreet, 1960; Jordaan and Heyde, 1979), and has been refined through several studies (Thompson et al., 1970), for its psychometric and conceptual adequacy. The content validity of the CDI scales is thus established by expert judgement in repeated examination of their content and psychometric characteristics that the items are relevant to various dimensions of the model.

Construct validity refers to the extent to which an instrument measures the characteristics that it claims to measure. It shows the degree to which performance on the instrument actually is associated with theoretically related characteristics or construct. The construct underlying the CDI is career-vocational maturity, a developmental characteristic. Evidence of the CDI's construct validity is based on subgroup differences (sex, grade, and program) and on the factor structure of the instrument.

The CDI does not discriminate between the sexes, with the CDI items being deliberately written in unisex terms. A basic theory of career development would predict minimal sex differences. Evidence presented in the User's Manual of the CDI (Thompson et al., 1981) show no significant differences in the means and variances between males and females on any of the scales. This infrequent and moderate sex difference is evidence of the construct validity of the CDI.

The underlying construct of the CDI is vocational maturity, which is a developmental process. Thus, it would be expected that mean scores would increase from grade 9 to grade 12. In fact, mean scores do show an increase, although the amount of increase varies from scale to scale. Although not all of the differences between the ninth and

twelfth grade means are meaningful in terms of construct validity criteria, the pattern of differences and their consistency from scale to scale are strong evidence of the construct validity of the CDI.

In examining construct validity, curricular differences were also considered in the User's Manual of the CDI (Thompson et al., 1981). In tenth, eleventh and twelfth grades it would be expected that honor students would have larger means, particularly on the cognitive scales, and it also would be expected that students in University Entrance and Business Education programs would have higher mean scores on the cognitive scale than those in general or vocational programs. Evidence presented in the User's Manual of the CDI (Thompson et al., 1981) shows this to be the case. However, on the attitudinal scales, the vocational-technical students scored higher, perhaps because they would be entering the work force sooner and thus have planned and explored more than other students. Thus, further evidence of construct validity of the CDI is provided.

Factor analyses provides additional information that is useful in the interpretation of construct validity. Factor analysis is used to determine how the items of a measurement instrument can best be grouped or categorized to form homogeneous subscales. Items that correlate highly with each other measure a single factor or interest area; items that fail to correlate with or load on any factor measured by the instrument are eliminated.

A factor analysis of the five basic scales by sex and grade showed that a two vocational maturity factor structure clearly existed - attitudinal and cognitive. It would be expected that CP and CE, being attitudinal in nature, should have high loadings on this factor. This happens consistently for each sex within each grade. The loadings are

large, ranging from .62 to .89. Thus, further evidence of construct validity is provided. Each of these relationships among the factors demonstrates that the CDI is related in expected ways to variables considered relevant in describing vocational maturity.

Comparisons of the CDI to other well known tests of vocational maturity is possible, the most common being the Crites Maturity Inventory (CMI) - 1973, The Assessment of Career Development (ACD) developed by the American College Testing Program (1973), and The Readiness for Vocational Planning by Gribbons and Tohnes (1971).

Of all the vocational measures available, the CDI has the most recent edition and has undergone several constructive and positive revisions. It requires the shortest time to administer - 65 minutes. Both the CMI and ACD each require 150 minutes. Also, the CDI appears to be the most reliable and valid.

The CDI may be used to ascertain the level of vocational maturity reached by different groups of students classified by age, sex, work experience, etc.

In this study, the standard scores for the scales of Career Planning (CP), Career Exploration (CE), Career Decision-Making (DM), World-of-Work Information (WW), Knowledge of Preferred Occupation (PO), and Career Development Orientation Total (COT) were used.

School Grades

For each of the selected students, letter grades were determined (by a check of past school records) in the following subjects: English, mathematics, science, social studies, physical education, and options at the senior high school (grade 10 and/or grade 11), where available. Each letter grade was ranked according to the following:

A+ - 6

A - 5

B - 4

C - 3

D - 2

F - 1

Collection of the Data

All pertinent data already known to school personnel was gathered directly from school files. A questionnaire for gathering additional demographic, attitudinal, and participation data was designed by the researcher and administered.

An informational newsletter and consent form was sent home in March 1984 via each of the selected students. This informational-consent letter is represented in Appendix B. This letter (which contained a section in which the parents or guardians were required to sign) had to be signed by a parent or responsible guardian giving approval before any student participated in the study. In some cases, due to forgetfulness on the part of the student to take the letter home, phone calls were made to the home. Failure to have the letter signed or a negative response by telephone would have prevented the student from participating in the study. None of the parents (or guardians) refused to give their consent, either by telephone or letter.

All students were subsequently and individually interviewed by the researcher.

None of the selected right-handed writers initially refused to participate and one withdrew from the study in its later stages. Two of the left-handed writers (one tenth grade female and one eleventh grade male)

immediately refused to participate in the study, citing that they felt it would interfere with their school work. All the students in the study were unequivocally informed that they had the right not to participate and could withdraw from the study at any time they deemed. The testing and collection of data was completed between March 1984 and May 1984. The researcher administered all questionnaires and inventories.

These included the Harris Tests of Lateral Dominance (1974) (as a check on hand dominance), the Estes Attitude Scales - Measures of Attitudes Toward School Subjects (1981) (English, mathematics, reading, science, and social studies), and the Career Development Inventory (1979) (Career Planning, Career Exploration, Career Decision-Making, World-of-Work Information, Knowledge of Preferred Occupation, and Career Development Orientation Total) and the questionnaire. These were administered to small groups of students as they were available. All collections were made by the researcher. All testing was done during regular school hours. There was no attempt to induce anxiety, embarrassment, distress, or any other "negative" stage. No deceptions were employed as the students were fully informed as to the purpose of each test administered. The students were informed that all comparisons would be made on a group basis and that at no time would there be any individual comparisons. All responses were strictly confidential and will not be used in any form or method detrimental to the students or the school.

Organization and Treatment of the Data

All statistical methods followed the analysis of variance model. Data was computerized at the University of Manitoba with SPSS

procedures being used in the statistical analyses. To answer the general research question, the following detailed anlayses was made of each datum, with comparisons being made of the two main sub-groups of:

all left-handed writers with all right-handed writers, and the minor sub-groups of:

all left-handed female writers with all right-handed female writers,

all left-handed male writers with all right-handed male writers,

all left-handed female writers with all left-handed male writers,

all tenth grade left-handed writers with all tenth grade right-handed writers,

all tenth grade left-handed female writers with all tenth grade right-handed female writers,

all tenth grade left-handed male writers with all tenth grade right-handed male writers,

all tenth grade left-handed female writers with all tenth grade left-handed male writers,

all eleventh grade left-handed writers with all eleventh grade right-handed writers,

all eleventh grade left-handed female writers with all eleventh grade right-handed female writers,

all eleventh grade left-handed male writers with all eleventh grade right-handed male writers,

all eleventh grade left-handed female writers with all eleventh grade left-handed male writers.

The collected data was dealt in terms of descriptive and inferential statistics. Discussion is made of the relevant variables and whether there was any significant differences between the various groups of left-handed and right-handed writers in respect to the variables. This study also examined whether sex and grade were a factor to be considered in the analyses of the variables. There are descriptive and inferential statistics for every variable (demographic, attitudinal, and achievement variables). Frequencies, percentages, degree of freedom, chi-square, and t tests were used to determine which variables and groups of variables were significant at the P 0.05 level. In addition, some studies have been cited to lend support to the findings of this present study. Further, as a means of providing additional information and analysis, several variables were subjected to a correlation test using the Pearson product-moment correlation coefficient. The results of this study are reported in the next chapter.

CHAPTER IV

PRESENTATION AND DISCUSSION OF RESULTS

Comparisons and analyses of secondary school left-handed and right-handed writers on selected demographic, attitudinal, and achievement variables by sex and grade are presented in this chapter.

Demographic Differences

Hand Dominance

Hand dominance, determined by the Harris Tests of Lateral Dominance (1974), was administered in order to verify the correct classification of the respondents into the two main sub-groups of all left- handed writers and all right-handed writers. The two groups were selected by the researcher by asking students whether they were left-handed or right-handed writers. They were examined for amount of handedness by means of the Harris Tests of Lateral Dominance (1974). For statistical purposes, left-handed writers were given a rating of 1 and right-handed writers a rating of 2. There was a strong positive correlation (.88) between measured scores and ratings, indicating that their reported handedness was highly valid.

There was indeed a very significant difference between left-handed and right-handed writers with respect to hand dominance, $X^2(4)=120$, $\underline{P}$ 0.001. None of the dextral writers exhibited any sinistral tendencies or mixed-ambidextrous tendencies (Table 1).

TABLE 1

Type of hand dominance as measured by the Harris Tests of Lateral Dominance

Group	Handedness	Degree of Hand Dominance					Chi-Square and ( ) Degrees of Freedom
		Strongly L.H.	Moderately L.H.	Ambidextrous	Moderately R.H.	Strongly R.H.	
Differences between Left Handed (L.H.) and Right-Handed (R.H.) Sub-groups							
		N %	N %	N %	N %	N %	
All Students (N = 120)	L.H.	23 (38.3)	19 (30.0)	19 (31.7)	0 (00.0)	0 (00.0)	120.00***
	R.H.	0 (00.0)	0 (00.0)	0 (00.0)	24 (40.0)	36 (60.0)	(4)
All Females (N = 40)	L.H.	3 (15.0)	5 (25.0)	12 (60.0)	0 (00.0)	0 (00.0)	40.00***
	R. H.	0 (00.0)	0 (00.0)	0 (00.0)	8 (40.0)	12 (60.0)	(4)
All Males (N = 80)	L.H.	20 (50.0)	13 (32.5)	7 (17.5)	0 (00.0)	0 (00.0)	80.00***
	R. H.	0 (00.0)	0 (00.0)	0 (00.0)	16 (40.0)	24 (60.0)	(4)
All Grade 10 Students (N = 56)	L.H.	12 (42.9)	8 (28.6)	8 (28.6)	0 (00.0)	0 (00.0)	56.00***
	R.H.	0 (00.0)	0 (00.0)	0 (00.0)	6 (21.4)	22 (78.6)	(4)
Grade 10 Females (N = 14)	L.H.	1 (14.3)	1 (14.3)	5 (71.4)	0 (00.0)	0 (00.0)	14.00***
	R.H.	0 (00.0)	0 (00.00)	0 (00.0)	1 (14.3)	6 (85.7)	(4)
Grade 10 Males (N = 42)	L.H.	11 (52.4)	7 (33.3)	3 (14.3)	0 (00.0)	0 (00.0)	42.00***
	R. H.	0 (00.0)	0 (00.0)	0 (00.0)	5 (23.8)	16 (76.2)	(4)
All Grade 11 Students (N = 64)	L.H.	11 (34.3)	10 (31.3)	11 (34.3)	0 (00.0)	0 (00.0)	64.00***
	R. H.	0 (00.0)	0 (00.0)	0 (00.0)	18 (56.3)	14 (43.7)	(4)
Grade 11 Females (N = 26)	L.H.	2 (15.3)	4 (30.8)	7 (53.8)	0 (00.0)	0 (00.0)	26.00***
	R.H.	0 (00.0)	0 (00.0)	0 (00.0)	7 (53.8)	6 (46.2)	(4)
Grade 11 Males (N = 38)	L.H.	9 (47.4)	6 (31.6)	4 (21.0)	0 (00.0)	0 (00.0)	38.00***
	R.H.	0 (00.0)	0 (00.0)	0 (00.0)	11 (57.9)	8 (42.1)	(4)
Differences between the Left-Handed Sub-Groups							
All L.H. Males		20 (50.0)	13 (32.5)	7 17.5)	0 (00.0)	0 (00.0)	12.11**
All L.H. Females (N = 60)		3 (15.0)	5 (25.0)	12 (60.0)	0 (00.0)	0 (00.0)	(2)
Grade 10 L.H. Males		11 (52.4)	7 (33.3)	3 (14.3)	0 (00.0)	0 (00.0)	8.44**
Grade 10 L.H. Females (N = 28)		1 (14.3)	1 (14.3)	5 (71.4)	0 (00.0)	0 (00.0)	(2)
Grade 11 L.H. Males		9 (47.4)	6 (31.6)	4 (21.0)	0 (00.0)	0 (00.0)	4.71*
Grade 11 L.H. Females (N = 32)		2 (15.3)	4 (30.8)	7 (53.8)	0 (00.0)	0 (00.0)	(2)

* Significant at $p < 0.05$ ** Significant at $p < 0.01$ *** Significant at $p < 0.001$

Of the right-handed respondents, 60 per cent were strongly right-handed and the remaining 40 per cent were moderately right-handed. None of the sinistral writers showed any strong dextral tendencies.

In comparing the right-handed male and right-handed female writers in respect to hand dominance, this study found absolutely no difference. Sixty per cent of the right-handed male writers were strongly right-handed and, identically, 60 per cent of the right-handed female writers were strongly right-handed. None of the right-handed respondents exhibited any ambidextrous tendencies.

It is interesting to note that almost one-third of the left-handed respondents were classified as ambidextrous by the test. This tends to suggest that, first of all, it is indeed a right-handed world, and in order for a left-handed individual to survive in daily routine, the right hand must be used frequently. Perhaps as a result of this, the left handers have had to learn to be more ambidextrous to cope with the large number of right-handed tasks required of them in their daily routine. The right hander is completely catered to in regards to use of his right hand, and so does not have to use his left hand in the vast majority of situations. Thus, the need and tendency for the right hander to become ambidextrous is greatly minimized.

Secondly, this study lends some support to those studies indicating that left-handed individuals are more varied in their brain lateralization, or have a greater degree of bilaterality between the hemispheres (Goodglass and Quadfasel, 1954; Hecaen and Piercy, 1956; Hecaen and De Ajuriaguerra, 1964; Hardyck and Petrinovich, 1977;

Hicks and Kinsbourne, 1978). Other measures of lateralization, such as dichotic listening tests, manual performance tests, conjugate eye movements during mental problem solving, and tachistoscopic studies have shown that left-handers have weaker lateralization than right-handers (Bryden, 1965; Satz et al., 1965; Kinsbourne, 1972; McGlone and Davidson, 1973; Gur, Gur, and Harris, 1975; McKeever and Van Deventer,1977; Hicks and Kinsbourne, 1978). Do the left-handers show more mixed or indeterminate dominance than dextrals? Several studies have strongly suggested that this is the case (Isom, 1967; Blau, 1974; Corballis and Beale, 1976; Hicks and Kinsbourne, 1978).

This study also gives support to the notion that the relationship between sex and left-handed dominance is significant. In all cases, when left-handed male and female writers were compared, regardless of the grade, the percentage of males who were either strongly left-handed or moderately left-handed was significantly higher, $X^2(2) = 12.11$, $P < 0.01$. The left-handed female writers tended to be significantly more ambidextrous or were moderately left-handed. Virtually none of the left-handed female writers exhibited any strong left-handed tendencies.

This present study tends to give credence to those studies that have found that sinistral males tend to be more strongly left-handed in comparison with sinistral females (Hecaen and De Ajurreguerra, 1964; Bakan, 1971; Oldfield, 1971; Bakan, Dibb, and Read, 1973; Satz, 1973; Flor-Henry, 1978; Barsley, 1979; Blakeslee, 1980; Marx, 1982).

Sex and Left-Handedness

Left-handed tenth and eleventh grade male writers significantly outnumbered the left-handed female writers by 66.7 per cent to 33.3 per cent, $X^2(1)=55.88$, $P < 0.001$. These results support previous

research on the connection between sinistrality and gender (Hecaen and De Ajurreguerra, 1964; Oldfield, 1971; Satz, 1973; Flor-Henry, 1978; Barsley, 1979; Blakeslee, 1980; Marx, 1982).

Program of Studies

A large majority (85.0 per cent) of the right-handed writers were arts and science (academic, including business education) students, while, in contrast, over half (51.7 per cent) of the left-handed writers were vocational students, $X^2(1)=18.15$, p 0.001 (Table 2).

All of the right-handed female writers were arts and science students, while 40 per cent of the left-handed female writers were in vocational programmes, $X^2(1)=7.65$, p 0.01.

The majority of the right-handed male writers were arts and science students (77.5 per cent), whereas the majority of the left-handed male writers were vocational students (57.5 per cent), $X^2(2)=8.80$, p 0.01.

The vast majority of the tenth grade right-handed writers were arts and science students (85.7 per cent), whereas 50 per cent of the tenth grade left-handed writers were vocational students, $X^2(1)=6.63$, p 0.01.

The majority of the eleventh grade right-handed writers were arts and science students (84.4 per cent), whereas over half of the eleventh grade left-handed writers were vocational students (53.1 per cent), $X^2(1)=8.38$, p 0.01.

Thus, in every situation, the majority of left-handed writers were vocational students, whereas most of the right-handed writers were academic students.

When left-handed male writers were compared with left-handed

female writers in respect to program of studies, there were no significant differences. Thus, it would appear that in general, vocational programs are not as academically demanding as the regular academic arts and science programs. The vocational programs tend to emphasize a more "hands on" approach with the theoretical aspects of the programs being more concrete, rather than abstract. Vocational programs also allow a more "artistic" expression of one's workmanship than do traditional academic programs.

The results of this study suggest that sinistral students tend to enroll in less academically demanding programs. Perhaps left-handed students can have more "artistic" self-expression in the vocational program. The findings of this study support previous conclusions that left-handed and right-handed individuals tend to use different brain hemispheres (Bakan, 1971; Krashen, 1975; Nebes, 1975; Herron, 1976; Ornstein, 1977), and this difference is expressed in choice of program of studies.

Birth Order

This study revealed no significant birth order differences between left-handed and right-handed writers. The majority of the respondents were either first or second born, a fact which may indeed reflect a recent trend in our society towards smaller families. None of the respondents indicated that they were of twin or multiple birth. This contradicts previous research that links sinistrality with twin birth (Gordon, 1920; Newman, 1940; Slater, 1961; Nagylaki and Levy, 1973).

Left-Handedness of Parents

This study sought to discover genetic causes of sinistrality by examining the left-handedness of the respondents' parents. A large percentage of both left-handed writers (76.7 per cent) and right-handed writers (86.7 per cent) did not have sinistral parents. Of those whose parents were sinistral, it was the mother that was more likely to be sinistral than the father. None of the respondents indicated both parents as being sinistral. In this study, one could not conclude that genetics alone accounts for sinistrality. This finding is consistent with other research concerned with genetics and sinistrality (Hecaen and De Ajurriaguerra, 1964; Corballis and Beale, 1976).

Left-Handedness of Siblings

The large majority of the left-handed writers (81.7 per cent) and the right-handed writers (85.0 per cent) did not have any sinistral siblings. This lack of difference further suggests that links between genetics and sinistrality tend to be tenuous. Thus, there does not appear to be any systematic order to genetic inheritance of sinistrality.

Extra-Curricular Activities

Large percentages of the respondents did not take part in student activities, but it was found 41.7 per cent of left-handed and 33.3 per cent of right-handed writers participated in at least one extra-curricular activity. There were no significant differences between the left-handed and the right-handed writers in respect to participation in extra-curricular activities. It is interesting to note that regardless of the respondents' handedness and grade, larger percentages of males than females were involved in extra-curricular

TABLE 2

Difference between left-handed and right-handed writers in programs of studies.

Group	Handedness	Program of Studies				Chi-Square and ( ) Degrees of Freedom
		Arts and Science		Vocational		
Differences between Left Handed (L.H.) and Right-Handed (R.H.) Sub-groups						
		N	%	N	%	
All students	L.H.	29	(48.3)	31	(51.7)	18.15***
(N=120)	R.H.	51	(85.0)	9	(15.0)	(1)
All females	L.H.	12	(60.0)	8	(40.0)	7.65**
(N=40)	R.H.	20	(100.0)	0	(00.0)	(1)
All males	L.H.	17	(42.5)	23	(57.5)	8.80**
(N=80)	R.H.	31	(77.5)	9	(22.5)	(1)
All grade 10 students	L.H.	14	(50.0)	14	(50.0)	6.63**
(N=56)	R.H.	24	(85.7)	4	(14.3)	(1)
Grade 10 females	L.H.	5	(71.4)	2	(28.6)	2.81*
(N=14)	R.H.	7	(100.0)	0	(00.0)	(1)
Grade 10 males	L.H.	9	(42.9)	12	(57.1)	4.94*
(N=42)	R.H.	17	(80.9)	4	(19.1)	(1)
All grade 11 students	L.H.	15	(46.9)	17	(53.1)	8.38**
(N=64)	R.H.	27	(84.4)	5	(15.6)	(1)
Grade 11 females	L.H.	7	(43.8)	6	(46.2)	5.41*
(N=26)	R.H.	13	(100.0)	0	(00.0)	(1)
Grade 11 males	L.H.	8	(42.1)	11	(57.9)	2.69*
(N=38)	R.H.	14	(73.7)	5	(26.3)	(1)
Differences between the Left-Handed subgroups						
All L.H. Males		17	(42.5)	23	(57.5)	1.00
All L.H. Females (N=60)		12	(60.0)	8	(40.0)	(1)
Grade 10 L.H. Males		9	(42.9)	12	(57.1)	0.76
Grade 10 L.H. Females (N=28)		5	(71.4)	2	(28.6)	(1)
Grade 11 L.H. Males		8	(42.1)	11	(57.9)	0.08
Grade 11 L.H. Females (N=32)		7	(53.8)	6	(46.2)	(1)

* Significant at $P < 0.05$ ** Significant at $P < 0.01$ ***Significant at $P < 0.001$

activities in every situation, although these differences were not significant.

Age

In general, the age distribution between left-handed and right-handed writers tended to be fairly equal. However, the left-handed writers were slightly older with 15 per cent of them having reached their 17th birthday, whereas only 6.6 per cent of the right-handed writers had reached their 17th birthday. Perhaps the finding that the left-handed writers tended to be slightly older is an indication that more of them have failed and repeated school grades.

Attitudinal Differences

Student Satisfaction With School

It is clear that the vast majority of students in this study like school. There were no significant differences between left-handed and right-handed writers in their expression of liking school. In comparison to the males, higher percentages of females expressed that they liked school. Perhaps this is an indication that females tend to do better in school and, as a result, like school better. It is presumed that individuals tend to express a liking of an activity if they are successful at that activity.

Student Greatest Satisfaction With School

There were several significant differences between left-handed and right-handed writers' expressions of what they like the most about school (Table 3).

In all cases, the right-handed writers liked school more for social

TABLE 3

What students liked best about school

Group	Handedness	Best liked about school				Chi-Square and ( ) Degrees of Freedom
		Social	Educational	Vocational	Interest	
Differences between Left Handed (L.H.) and Right-Handed (R.H.) Sub-groups						
		N %	N %	N %	N %	
All Students	L.H.	23 (39.7)	21 (36.2)	6 (10.3)	8 (13.8)	8.42*
(N = 120)	R.H.	38 (65.5)	12 (20.7)	2 (3.4)	6 (10.3)	(3)
All Females	L.H.	9 (45.0)	6 (30.0)	1 (5.0)	3 (15.0)	2.49
(N = 40)	R. H.	12 (60.0)	5 (25.0)	0 (00.0)	1 (5.0)	(3)
All Males	L.H.	14 (35.0)	15 (38.5)	5 (12.5)	5 (12.5)	7.78*
(N = 80)	R. H.	26 (65.0)	7 (17.5)	2 (5.0)	5 (12.5)	(3)
All Grade 10 Students	L.H.	8 (28.6)	13 (46.4)	3 (10.7)	3 (10.7)	7.40*
(N = 56)	R.H.	18 (64.2)	6 (21.4)	1 (3.8)	3 (10.7)	(3)
Grade 10 Females	L.H.	1 (14.2)	4 (57.1)	0 (00.0)	1 (14.2)	2.88
(N = 14)	R.H.	4 (57.1)	3 (42.9)	0 (00.0)	0 (00.0)	(2)
Grade 10 Males	L.H.	7 (33.3)	9 (42.9)	3 (14.3)	2 (9.5)	6.53*
(N = 42)	R. H.	14 (66.7)	3 (14.3)	1 (4.8)	3 (14.3)	(3)
All Grade 11 Students	L.H.	15 (46.9)	8 (25.0)	3 (14.3)	5 (23.8)	2.48
(N = 64)	R. H.	20 (62.5)	6 (28.6)	1 (3.1)	3 (9.3)	(3)
Grade 11 Females	L.H.	8 (61.5)	2 (15.4)	1 (7.7)	2 (15.4)	1.17
(N = 26)	R.H.	8 (61.5)	2 (15.4)	0 (00.0)	1 (7.7)	(3)
Grade 11 Males	L.H.	7 (36.8)	6 (31.6)	2 (10.5)	3 (15.8)	2.22
(N = 38)	R.H.	12 (63.2)	4 (21.0)	1 (5.3)	2 (10.5)	(3)
Differences between the Left-Handed Sub-Groups						
All L.H. Males		14 (35.0)	15 (38.5)	5 (12.5)	5 (12.5)	1.37
All L.H. Females (N = 60)		9 (45.0)	6 (30.0)	1 (5.0)	3 (15.0)	(3)
Grade 10 L.H. Males		7 (33.3)	9 (42.9)	3 (14.3)	2 (9.5)	2.05
Grade 10 L.H. Females (N = 28)		1 (14.2)	4 (57.1)	0 (00.0)	1 (14.2)	(3)
Grade 11 L.H. Males		7 (36.8)	6 (31.6)	2 (10.5)	3 (15.8)	1.84
Grade 11 L.H. Females (N = 32)		8 (61.5)	2 (15.4)	1 (7.7)	2. (15.4)	(3)

* Significant at $p < 0.05$

reasons. For example, "I like school because I can go there and meet my friends". The left-handed writers tended to enjoy school more for educational reasons. For example, "I need an education to get a job". It is not surprising that since there were more left-handed writers in vocational programs, a higher percentage expressed that their vocational program was their greatest satisfaction with school.

Student Greatest Dissatisfaction With School

The respondents were requested to state on the questionnaire what they disliked the most about school. Response statements were divided into six classifications: boring, rules, exams, work, teachers, and other. According to the respondents, the greatest dissatisfactions of school listed in descending order are: work (34.2 per cent), rules (26.7 per cent), boring (16.7 per cent), teachers (12.5 per cent), and exams (4.2 per cent). There were no statistically significant differences between left-handed and right-handed writers in respect to their greatest dislike of school. Some (34.2 per cent) felt that school required too much homework, study time, assignment time, etc. Others (26.7 per cent) disliked the many rules regarding student behavior and conduct. Many wrote that school rules treated them like children and not as young adults. Perhaps this is a sign of general adolescent rebellion against rules and regulation. In general, the respondents did not greatly dislike their teachers. Only 13 per cent listed teachers as being their main dissatisfaction with school.

School Subjects Liked the Most

The respondents were requested to list the subject they liked the most in school. The subjects were classified into eight areas: English,

mathematics, science (biology, chemistry, physics, general science), social studies (geography, history), physical education, fine arts (language, music, art, drama), business education (retailing, typing, economics, etc.), and vocational. There were no statistical differences in sub- jects most liked between left-handed and right-handed writers.

Of the right-handed writers, 33.3 per cent listed mathematics and 21 per cent listed science as their best liked subjects. A smaller percentage of the left-handed respondents listed mathematics (20.0 per cent) and science (11.7 per cent) as their best liked subjects. The left-handed writers listed in larger percentages the non-mathematical and non-scientific subjects as being better liked (English, social studies, physical education, fine arts, business education, and vocational).

This study tends to support those studies (Krashen, 1975; Nebes, 1975; Herron, 1976; Ornstein, 1977) which indicated that sinistral individuals were different in their brain lateralization from dextral individuals. Those studies further suggested that sinistral people tended to be more intuitive, spatial, artistic, and gestalt than right-handed individuals who tended to be more linear, serial, and rational. If this is indeed the case, school subjects like mathematics and science would favour right-handed students, whereas subjects like English, social studies, fine arts, and physical education would favour sinistral students. Forty-five per cent of the left-handed writers in this study did not list mathematics or science as their best liked subjects. This may be an indication that the left-handed writers in this study are more "right brain" orientated than the right-handed writers, and this difference is reflected in their expression of subjects liked best.

Attitude Towards School Subjects

Attitudes towards school subjects were determined by using the Estes Attitude Scales-Measures of Attitudes Toward School Subjects. The scale is designed to measure subject attitudes in five areas - English, mathematics, reading, science, and social studies. Table 4 contains the means, standard deviation, t values, and degrees of freedom of comparisons. The higher the score, the more positive the attitude towards that school subject. The results showed that the total group of right-handed writers exceeded left-handed writers in positive attitude towards mathematics, $t(11)=3.10$, P 0.01. The left- handed writers had more positive attitudes towards social studies, $t(11)=2.40$, P 0.01. Although differences were not statistically significant, left-handed writers had a higher mean score in English, reading, and social studies, whereas right-handed writers scored higher mean values in mathematics and science.

Left-handed male writers had a significantly more positive attitude towards English than right-handed male writers, $t(78)=2.39$, P 0.01. On the other side, right-handed male writers had significantly more positive attitudes towards mathematics, than did left-handed male writers, $t(78)=2.33$, P 0.01.

Regardless of handedness, males had more positive attitudes towards mathematics, whereas females had more positive attitudes towards English, reading, and social studies, although in many cases these differences were not statistically significant.

Career Development and Vocational Maturity

Right-handed writers consistently had higher mean scores on the Career Development Inventory than did left-handed writers (Table 5).

TABLE 4

Attitudes towards school subject as determined by the Estes Attitude Scales

Group	Handedness	ENGLISH X	ENGLISH (SD)	MATHEMATICS X	MATHEMATICS (SD)	READING X	READING (SD)	SCIENCE X	SCIENCE (SD)	SOCIAL STUDIES X	SOCIAL STUDIES (SD)
All students (N=120)	L.H.	49.38	(9.83)	53.65	(9.04)	52.55	(11.23)	54.28	(8.64)	50.75	(9.88)
	R.H.	47.00	(11.22)	58.41	(7.76)	51.91	(11.15)	54.60	(7.34)	46.15	(11.04)
t (df)		1.24	(11)	-3.10**	(11)	0.31	(11)	-0.22	(11)	2.40**	(11)
All females (N=40)	L.H.	50.50	(8.76)	52.95	(8.94)	55.75	(10.28)	50.65	(8.62)	52.40	(8.00)
	R.H.	53.15	(7.85)	52.92	(9.68)	58.92	(6.31)	50.92	(6.07)	51.15	(7.89)
t (df)		-1.98	(38)	0.02	(3.8)	-2.03**	(38)	-0.19)	(38)	0.95	(38)
All males (N=80)	L.H.	48.82	(10.38)	54.00	(9.19)	50.95	(11.46)	56.10	(8.17)	49.92	(10.70)
	R.H.	43.67	(8.79)	58.57	(8.34)	48.42	(10.48)	56.32	(5.91)	45.95	(10.87)
t (df)		2.39**	(38)	-2.33**	(78)	1.03	(78)	-0.14	(78)	1.65	(78)
All grade 10 students (N=56)	L.H.	46.71	(10.23)	53.89	(8.85)	47.96	(11.42)	54.60	(9.56)	51.25	(10.16)
	R.H.	47.07	(11.24)	58.07	(8.35)	50.78	(10.28)	55.60	(6.59)	48.42	(11.78)
t (df)		-0.12	(54)	-1.82	(54)	-0.97	(54)	-0.46	(54)	0.96	(54)
Grade 10 females (N=14)	L.H.	45.57	(8.73)	53.00	(8.12)	49.85	(13.87)	50.14	(12.69)	54.71	(8.30)
	R.H.	50.00	(8.89)	60.71	(6.72)	55.71	(13.04)	50.42	(8.34)	45.42	(7.69)
t (df)		0.56	(12)	-1.94	(12)	-0.81	(12)	-0.05	(12)	-1.26	(12)
Grade 10 males (N=42)	L.H.	47.09	(10.85)	54.19	(9.25)	47.33	(10.80)	56.09	(8.11)	50.09	(10.64)
	R.H.	46.09	(7.71)	57.19	(8.80)	49.14	(8.96)	57.33	(5.03)	49.42	(9.44)
t (df)		0.34	(40)	-1.08	(40)	-0.59	(40)	-0.59	(40)	0.21	(40)
All grade 11 students (N=64)	L.H.	51.71	(8.98)	53.43	(9.35)	55.56	(9.53)	54.00	(7.90)	50.31	(9.98)
	R.H.	46.93	(11.39)	58.71	(7.33)	52.90	(11.93)	53.71	(7.94)	44.15	(10.13)
t (df)		1.86	(62)	-2.51**	(62)	1.35	(62)	0.14	(62)	2.47**	(62)
Grade 11 females (N=26)	L.H.	53.15	(7.85)	52.92	(9.68)	58.92	(6.31)	50.92	(6.07)	51.15	(7.89)
	R.H.	55.61	(8.19)	56.69	(6.40)	60.61	(6.19)	51.53	(9.30)	47.15	(7.61)
t (df)		-0.78	(24)	-1.17	(24)	-0.69	(24)	-0.20	(24)	1.32	(24)
Grade 11 males (N=38)	L.H.	50.73	(9.76)	53.78	(9.36)	54.94	(11.10)	56.10	(8.45)	49.73	(11.06)
	R.H.	41.00	(9.33)	60.10	(7.76)	47.63	(12.14)	55.21	(6.71)	42.10	(11.27)
t (df)		3.14**	(36)	-2.26*	(36)	1.94	(36)	0.36	(36)	2.11*	(36)
Differences between the Left-Handed sub-groups											
All L.H. Males (N=60)		48.82	(10.38)	54.00	(9.19)	50.90	(11.46)	56.10	(8.17)	49.92	(10.70)
All L.H. Females		50.50	(8.76)	52.95	(8.94)	55.75	(10.28)	50.65	(8.62)	52.40	(8.00)
t (df)		0.62	(58)	0.42	(58)	1.58	(58)	-2.39*	(58)	0.91	(58)
Grade 10 L.H. Males (N=28)		47.09	(10.85)	54.19	(9.25)	47.33	(10.80)	56.09	(8.11)	50.09	(10.64)
Grade 10 L.H. Females		45.57	(8.73)	53.00	(8.12)	49.85	(13.87)	50.14	(12.69)	54.71	(8.30)
t (df)		-0.34	(26)	-0.30	(26)	0.50	(26)	-1.45	(26)	1.04	(26)
Grade 11 L.H. Males (N=32)		50.73	(9.76)	53.78	(9.36)	54.94	(11.10)	56.10	(8.45)	49.73	(11.06)
Grade 11 L.H. Females		53.15	(7.85)	52.92	(9.68)	58.92	(6.31)	50.92	(6.07)	51.15	(7.89)
t (df)		0.74	(30)	-0.25	(30)	1.16	(30)	-1.90	(30)	0.40	(30)

*Significant at $P < 0.05$ **Significant at $P < 0.01$

TABLE 5

Vocational Maturity as determined by the CDI Form

Group	Handedness	CP X̄	CP (SD)	CE X̄	CE (SD)	DM X̄	DM (SD)	WW X̄	WW (SD)	PO X̄	PO (SD)	COT X̄	COT (SD)
Differences between Left Handed (L.H.) and Right Handed (R.H.) sub-groups.													
All students (N=120)	L.H.	97.50	(17.57)	93.28	(18.11)	97.98	(15.39)	105.15	(13.06)	105.64	(12.24)	98.16	(16.63)
	R.H.	100.91	(16.65)	109.53	(16.31)	102.83	(17.25)	107.83	(14.30)	111.25	(12.13)	104.53	(16.06)
t (df)		-1.09	(11)	-1.97*	(11)	-1.62	(11)	-1.07	(11)	-2.51**	(11)	-2.13*	(11)
All females (N=40)	L.H.	93.55	(17.00)	93.30	(15.66)	107.65	(12.96)	112.80	(8.65)	109.10	(10.99)	102.10	(12.49)
	R.H.	97.07	(17.28)	95.61	(17.13)	110.46	(10.01)	113.76	(7.89)	110.76	(10.29)	105.53	(12.83)
t (df)		-1.29	(38)	-0.90	(38)	-1.35	(38)	-0.67	(38)	-0.92	(38)	-1.77	(38)
All males (N=80)	L.H.	99.47	(17.73)	93.27	(19.41)	93.15	(14.31)	101.32	(13.28)	103.95	(12.61)	96.20	(18.18)
	R.H.	100.12	(17.04)	112.85	(14.63)	99.92	(17.96)	103.85	(14.92)	108.62	(11.82)	101.72	(17.25)
t (df)		-0.17	(78)	-1.61	(78)	-1.87	(78)	-0.80	(78)	-1.71	(78)	-1.39	(78)
All grade 10 students (N=56)	L.H.	93.92	(15.95)	92.82	(13.05)	93.50	(15.19)	103.75	(10.55)	103.71	(11.71)	93.89	(10.40)
	R.H.	100.17	(15.62)	117.60	(17.93)	99.42	(13.56)	102.10	(14.27)	107.71	(12.06)	100.07	(15.26)
t (df)		-1.48	(54)	-1.78	(54)	-1.54	(54)	0.49	(54)	-1.26	(54)	-1.77	(54)
Grade 10 females (N=14)	L.H.	87.00	(15.51)	89.00	(12.50)	102.42	(16.81)	111.00	(10.32)	105.00	(12.38)	95.71	(9.58)
	R.H.	100.42	(14.72)	97.14	(13.12)	103.28	(15.09)	111.00	(9.32)	118.57	(13.77)	103.85	(8.89)
t (df)		-1.66	(12)	-1.19	(12)	-0.10	(12)	0.0	(12)	-1.80	(12)	-1.65	(12)
Grade 10 males (N=42)	L.H.	96.23	(15.77)	94.09	(13.27)	90.52	(13.77)	101.33	(9.69)	102.95	(11.69)	93.28	(10.82)
	R.H.	100.09	(16.26)	124.42	(10.95)	98.14	(13.15)	99.14	(14.57)	104.09	(9.20)	98.80	(16.86)
t (df)		-0.21	(62)	-1.77	(62)	-0.90	(62)	-1.88	(62)	-2.31*	(62)	-1.44	(62)
All grade 11 students (N=64)	L.H.	100.62	(18.56)	93.68	(21.82)	101.90	(14.70)	106.37	(14.97)	107.37	(12.63)	101.90	(20.03)
	R.H.	101.56	(17.72)	102.46	(17.59)	105.81	(19.66)	112.84	(12.51)	114.34	(11.50)	108.43	(15.94)
t (df)		-0.21	(62)	-1.77	(62)	-0.90	(62)	-1.88	(62)	-2.31*	(62)	-1.44	(62)
Grade 11 females (N=26)	L.H.	97.07	(17.28)	95.61	(17.13)	110.46	(10.01)	113.76	(7.89)	110.76	(10.29)	105.53	(12.83)
	R.H.	103.61	(17.32)	106.00	(12.24)	111.53	(13.78)	118.38	(7.80)	115.38	(10.10)	113.53	(12.12)
t (df)		-0.96	(24)	-1.78	(24)	-0.23	(24)	-1.50	(24)	-1.15	(24)	-1.63	(24)
Grade 11 males (N=38)	L.H.	103.05	(19.46)	92.36	(24.89)	96.05	(14.71)	101.31	(16.67)	105.05	(13.78)	99.42	(23.78)
	R.H.	100.15	(18.33)	100.05	(20.44)	101.89	(22.34)	109.05	(13.84)	113.63	(12.59)	104.94	(17.55)
t (df)		0.47	(36)	-1.04	(36)	-0.95	(36)	-1.56	(36)	-2.00*	(36)	-0.81	(36)
Differences between the Left-Handed sub-groups													
All L.H. Males (N=60)		99.47	(17.73)	93.27	(19.41)	93.15	(14.31)	101.32	(13.28)	03.95	(12.61)	96.20	(18.18)
All L.H. Females		93.55	(17.00)	93.30	(15.66)	107.65	(12.96)	112.80	(8.65)	09.10	(10.99)	102.10	(12.49)
t (df)		-1.24	(58)	0.00	(58)	3.81***	(58)	3.50***	(58)	1.55	(58)	1.30	(58)
Grade 10 L.H. Males (N=28)		96.23	(15.77)	94.09	(13.27)	90.52	(13.77)	101.33	(9.69)	02.95	(11.69)	93.28	(10.82)
Grade 10 L.H. Females		87.00	(15.51)	89.00	(12.50)	102.42	(16.81)	111.00	(10.32)	05.00	(12.38)	95.71	(9.58)
t (df)		-1.35	(26)	-0.89	(26)	1.88	(26)	2.25*	(26)	0.59	(26)	0.53	(26)
Grade 11 L.H. Males (N=32)		103.05	(19.46)	92.36	(24.89)	96.05	(14.71)	101.31	(16.67)	05.05	(13.78)	99.42	(23.78)
Grade 11 L.H. Females		97.07	(17.28)	95.61	(17.13)	110.46	(10.01)	113.76	(7.89)	110.76	(10.29)	105.53	(12.83)
t (df)		-0.89	(30)	0.41	(30)	3.07**	(30)	2.50*	(30)	1.27	(30)	0.84	(30)

* Significant at $P < 0.05$ ** Significant at $P < 0.01$ ***Significant at $P < 0.001$

Statistically significant differences were in Career Exploration (CE), $t(11)=1.97$, $P < 0.05$, Occupational Knowledge (PO) $t(11)=2.51$, $P < 0.01$, and Career Occupational Total (COT), $t(11)=2.13$, $P < 0.01$. The COT is considered to be a measure of vocational maturity as it measures four of the five basic dimensions in Super's (1974) model of vocational maturity.

Thus, it would appear, from this study, that the right-handed writer respondents have a greater measure of vocational maturity (which is a developmental process) than the left-handed writer respondents. This would support previous reports that sinistral individuals suffer more deficits in their developmental processes than do dextral individuals (Hecaen and De Ajuriaguerra, 1964; Bakan, 1971; Blai, 1971; Hanvik and Kaste, 1973; Bernstein et al., 1974; Blau, 1974; Geschwind and Behan, 1982; Ohlendorf, 1982).

Female respondents consistently outscored males. This finding is consistent with the studies that have found that adolescent females tend to have higher mean scores than do adolescent males on career maturity measures.

Achievement Differences

Final Subject Marks Achieved

The right-handed writers scored consistently higher in all of the six subject areas than did the left-handed writers (Table 6). When there is a comparison of left-handed and right-handed female writers, we find no statistically significant differences, although the right-handed female writers scored higher mean values in all cases. When we compare the left-handed male writers with the right-handed male

TABLE 6
Final Marks in the Six Subject Areas

Group	Handedness	ENGLISH X	ENGLISH (SD)	MATHEMATICS X	MATHEMATICS (SD)	SOCIAL STUDIES X	SOCIAL STUDIES (SD)	PHYS. ED X	PHYS. ED (SD)	SCIENCE X	SCIENCE (SD)	OPTIONS X	OPTIONS (SD)
Differences between Left Handed (L.H.) and Right Handed (R.H.) sub-groups.													
All students (N=120)	L.H.	3.06	(0.89)	2.95	(1.24)	2.93	(1.14)	3.58	(0.72)	3.11	(1.78)	3.14	(1.14)
	R.H.	3.60	(0.88)	3.68	(0.93)	3.75	(0.98)	4.01	(0.77)	3.77	(1.21)	3.58	(0.78)
t (df)		-3.27***	(118)	-3.66***	(118)	-4.18	(118)	-3.12**	(118)	-3.08	(118)	-2.23*	(118)
All females (N=40)	L.H.	3.30	(0.75)	3.15	(1.35)	3.35	(0.98)	3.47	(0.84)	3.84	(1.28)	3.70	(1.17)
	R.H.	3.50	(1.00)	3.40	(1.21)	3.35	(1.22)	3.58	(0.66)	3.90	(1.25)	3.76	(1.23)
t (df)		-1.18	(38)	-1.12	(38)	-0.97	(38)	-0.73	(38)	-0.26	(38)	-0.35	(38)
All males (N=80)	L.H.	2.85	(0.77)	2.72	(1.13)	2.72	(1.06)	3.64	(0.66)	2.72	(1.06)	2.92	(1.04)
	R.H.	3.35	(0.80)	3.40	(0.81)	3.45	(0.87)	4.00	(0.75)	3.55	(1.03)	3.40	(0.74)
t (df)		-2.84**	(78)	-3.07**	(78)	-3.33***	(78)	-2.24*	(77)	-3.52***	(78)	-2.34*	(78)
All grade 10 students (N=56)	L.H.	3.14	(1.00)	2.92	1.38)	3.00	1.33)	3.60	(0.78)	3.10	(1.16)	2.92	(1.05)
	R.H.	3.42	(0.92)	3.35	(0.82)	3.42	(0.92)	3.96	(0.69)	3.50	(1.10)	3.25	(0.70)
t (df)		-1.11	(54)	-1.41	(54)	-1.40	(54)	-1.80	(54)	-1.29	(54)	-1.35	(54)
Grade 10 females (N=14)	L.H.	3.85	(1.00)	3.85	(1.57)	3.71	(1.60)	3.28	(1.11)	4.00	(1.29)	3.55	(1.13)
	R.H.	4.14	(0.69)	4.00	(0.81)	4.14	(0.37)	3.85	(0.37)	4.00	(1.15)	3.57	(0.53)
t (df)		-0.50	(12)	-0.21	(12)	-0.69	(12)	-1.29	(12)	0.00	(12)	0.00	(12)
Grade 10 males (N=42)	L.H.	2.90	(0.76)	2.61	(1.20)	2.76	(1.17)	3.71	(0.64)	2.80	(0.98)	2.71	(0.95)
	R.H.	3.19	(0.87)	3.14	(0.72)	3.19	(0.92)	4.00	(0.77)	3.33	(1.06)	3.14	(0.72)
t (df)		-1.13	(40)	-1.71	(40)	-1.31	(40)	-1.30	(40)	-1.66	(40)	-1.64	(40)
All grade 11 students (N=64)	L.H.	3.00	(0.80)	2.96	(1.12)	2.87	(0.97)	3.56	(0.67)	3.12	(1.33)	3.40	(1.18)
	R.H.	3.75	(0.84)	3.96	(0.93)	4.03	(0.96)	4.06	(0.84)	4.03	(1.09)	3.87	(0.75)
t (df)		-3.64***	(62)	-3.88***	(62)	-4.76***	(62)	-2.55**	(60)	-2.97**	(62)	-1.89	(62)
Grade 11 females (N=26)	L.H.	3.30	(0.75)	3.15	(1.21)	3.15	(0.98)	3.58	(0.66)	3.84	(1.28)	3.76	(1.23)
	R.H.	4.07	(0.95)	4.38	(0.96)	4.46	(1.12)	4.15	(0.98)	4.38	(1.19)	4.15	(0.80)
t (df)		-2.28*	(24)	-2.87*	(24)	-3.15**	(24)	-1.68	(23)	-1.11	(24)	-0.94	(24)
Grade 11 males (N=38)	L.H.	2.78	(0.78)	2.84	(1.06)	2.68	(0.94)	3.55	(0.70)	2.63	(1.16)	3.15	(1.11)
	R.H.	3.52	(0.69)	3.68	(0.82)	3.73	(0.73)	4.00	(0.74)	3.78	(0.97)	3.68	(0.67)
t (df)		-3.06**	(36)	-2.73***	(36)	-3.03***	(36)	-1.86	(35)	-3.32**	(36)	-1.76	(36)
Differences between the Left-Handed sub-groups													
All L.H. Males (N=60)		2.85	(0.77)	2.72	(1.13)	2.72	(1.06)	3.64	(0.66)	2.72	(1.06)	2.92	(1.04)
All L.H. Females		3.30	(0.75)	3.15	(1.35)	3.15	(0.98)	3.47	(0.84)	3.84	(1.28)	3.70	(1.17)
t (df)		2.79**	(58)	2.04*	(58)	2.04*	(58)	-0.82	(56)	3.80***	(58)	2.60**	(58)
Grade 10 L.H. Males (N=28)		2.90	(0.76)	2.61	(1.20)	2.76	(1.17)	3.71	(0.64)	2.80	(0.98)	2.71	(0.95)
Grade 10 L.H. Females		3.85	(1.34)	3.85	(1.57)	3.71	(1.60)	3.28	(1.11)	4.00	(1.29)	3.55	(1.13)
t (df)		2.34*	(26)	2.18*	(26)	1.69	(26)	-1.26	(26)	2.57**	(26)	1.96	(26)
Grade 11 L.H. Males (N=32)		2.78	(0.78)	2.84	(1.06)	2.68	(0.94)	3.55	(0.70)	2.63	(1.16)	3.15	(1.11)
Grade 11 L.H. Females		3.30	(0.75)	3.15	(1.21)	3.15	(0.98)	3.58	(0.66)	3.84	(1.28)	3.76	(1.23)
t (df)		1.85	(30)	0.77	(30)	1.36	(30)	0.11	(28)	2.78**	(30)	1.46	(30)

* Significant at P 0.05 ** Significant at P 0.01 ***Significant at P 0.001

writers, we find indeed that in all cases, there are significant differences. The right-handed males achieved much higher final subject marks. In a comparison of left-handed female writers with left-handed male writers, the females consistently received a higher final mark, even in the subject areas of mathematics and science. With the exception of physical education, all differences between the two were statistically significant. Left-handed male writers, then, were the lowest achievers in this study.

At the tenth grade level, a comparison between the left-handed writers and the right-handed writers shows no statistically significant differences, although in all cases the right-handed writers achieved higher final subject marks. At the eleventh grade, the right-handed writers achievement of final subject marks was far superior.

Highest Mark Received

The respondents were requested to list the school subject in which they received their highest mark. There were no statistically significant differences between left-handed and right-handed writers on this item.

Of the right-handed writers, 30 per cent indicated that their highest mark was in mathematics, 28.3 per cent indicated science, and 13.3 per cent chose English. In the sample of left-handed writers, 25 per cent selected mathematics, 16.7 per cent chose science, and 18.3 per cent selected English. Although these percentage differences between the two groups of left-handed and right-handed writers were not statistically significant, it does seem to follow the general trend of subject preferences. The right-handed writers tended to like mathematics-science oriented subjects and so were more likely to get

their highest marks in these subjects. The left-handed writers were more likely to dislike the mathematics and science subjects, and so were less likely to indicate receiving higher marks in these school subjects.

Lowest Mark Received

On the questionnnaire, the respondents were requested to list the school subject in which they received their lowest mark. There were only chance differences between left-handed and right-handed writers in respect to this item.

Student Self-Rating of Success

The respondents were requested to rate how well they succeeded in school (Table 7). Many more right-handed than left-handed writers saw themselves as being good students, $X^2(4)=15.17$, p 0.0l. This is not surprising, considering that this study found that the right-handed writers received higher final marks in school (Table 6). School success may lead one to perceive oneself as being a good student.

At the eleventh grade, more right-handed than left-handed writers rated themselves as good students, $X^2(3)=15.07$, p 0.0l. At the tenth grade, a higher percentage of the right-handed writers indicated they were good students, although the differences were not statistically significant.

Regardless of handedness, a higher percentage of females than males perceived themselves as good students, although the differences were not statistically significant.

TABLE 7

Self-rating of Success

Group	Handedness	Student Self-Rating of Success: Top-Ten	Top Twenty-Five	Top Fifty	Lowest Half	Lowest Ten	Chi-Square and ( ) Degrees of Freedom
Differences between Left Handed (L.H.) and Right-Handed (R.H.) Sub-groups							
		N %	N %	N %	N %	N %	
All Students	L.H.	4 (6.7)	16 (26.7)	33 (55.0)	6 (10.0)	1 (1.7)	15.17**
(N = 120)	R.H.	10 (16.7)	30 (50.0)	19 (31.7)	1 (1.7)	0 (00.0)	(4)
All Females	L.H.	2 (10.0)	6 (30.0)	10 (50.0)	1 (5.0)	1 (5.0)	9.08*
(N = 40)	R. H.	5 (25.0)	12 (60.0)	3 (15.0)	0 (00.0)	0 (00.0)	(4)
All Males	L.H.	2 (5.0)	10 (25.0)	23 (57.5)	5 (12.5)	0 (00.0)	7.49*
(N = 80)	R. H.	5 (12.5)	18 (45.0)	16 (40.0)	1 (2.5)	0 (00.0)	(3)
All Grade 10 Students	L.H.	3 (10.7)	8 (28.6)	14 (50.0)	2 (7.1)	1 (3.6)	4.34
(N = 56)	R.H.	3 (10.7)	13 (46.4)	12 (42.9)	0 (00.0)	0 (00.0)	(4)
Grade 10 Females	L.H.	2 (28.5)	2 (28.5)	2 (28.5)	0 (00.0)	1 (14.5)	2.00
(N = 14)	R.H.	2 (28.5)	4 (57.0)	1 (14.5)	0 (00.0)	0 (00.0)	(3)
Grade 10 Males	L.H.	1 (4.8)	6 (28.6)	12 (57.1)	2 (9.5)	0 (00.0)	2.64
(N = 42)	R. H.	1 (4.8)	9 (42.9)	11 (52.4)	0 (00.0)	0 (00.0)	(3)
All Grade 11 Students	L.H.	1 (3.1)	8 (25.0)	19 (59.4)	4 (12.5)	0 (00.0)	15.07**
(N = 64)	R. H.	7 (21.9)	17 (53.1)	7 (21.9)	1 (3.1)	0 (00.0)	(3)
Grade 11 Females	L.H.	0 (00.0)	4 (30.8)	8 (61.5)	1 (7.7)	0 (00.0)	8.93*
(N = 26)	R.H.	3 (23.1)	8 (61.5)	2 (15.4)	0 (00.0)	0 (00.0)	(3)
Grade 11 Males	L.H.	1 (5.3)	4 (21.1)	11 (57.9)	3 (15.8)	0 (00.0)	6.97
(N = 38)	R.H.	4 (21.1)	9 (47.4)	5 (26.3)	1 (5.3)	0 (00.0)	(3)
Differences between the Left-Handed Sub-Groups							
All L.H. Males		2 (5.0)	10 (25.0)	23 (57.5)	5 (12.5)	0 (00.0)	3.51
All L.H. Females (N = 60)		2 (10.0)	6 (30.0)	10 (50.0)	1 (5.0)	1 (5.0)	(4)
Grade 10 L.H. Males		1 (4.8)	6 (28.6)	12 (57.1)	2 (9.5)	0 (00.0)	7.30
Grade 10 L.H. Females (N = 28)		2 (28.5)	2 (28.5)	2 (28.5)	0 (00.0)	1 (14.5)	(4)
Grade 11 L.H. Males		1 (5.3)	4 (21.1)	11 (57.9)	3 (15.8)	0 (00.0)	1.39
Grade 11 R.H. Females (N = 32)		3 (23.1)	8 (61.5)	2 (15.4)	0 (00.0)	0 (00.0)	(3)

* Significant at $p < 0.05$ ** Significant at $p < 0.01$

Summary

This study clearly found that right-handed writers received higher final marks in school subjects than did left-handed writers. This supports those previous studies that reported that sinistral students suffer more from learning disabilities and deficits in general, and so are more likely not to achieve very positively in school.

However, there are also those researchers who argue that sinistral students do not do as well in school because they are out of brain "sync" with the school system (Bogen, 1975; Gazzaniga, 1975; Samples, 1975; Hunter, 1976; Rennels, 1976; Baty and McConnell, 1976; Regelski, 1977; Lutz, 1978; Raina, 1979; Fox, 1980; Schwartz, 1980). These researchers would argue that the educational system is rational, logical, linear, and highly biased towards left hemisphere functioning and antithetical to the right brain functioning. Reading, writing, and mathematics are all logical-linear processes fed into the brain through the right hand. Schools have tended to aggravate and prolong this one-sidedness. School systems emphasize the logical and propositionally rather than the analogical and oppositionality. Because, it can be argued, the sinistral student is more apt to be right-brain orientated than are dextral students, the left-handed student is at a great disadvantage in the educational system. The sinistral student who tends to be more holistic and analogic, is "learning disabled" in a rational, logical, and linear system. If, indeed, this is the case, it is not surprising that the left-handed student tends not to perform as well in school as the right-handers.

Further correlational analysis were done on Lateral Dominance, attitudinal variables, and achievement variables. Since there were several significant differences between right-handed and left-handed

writers in attitudinal and achievement variables, this suggests that hand dominance is related to students' subject attitude and achievement. The correlation between Lateral Dominance, attitude, and achievement was a further check on this speculation. There appears to be a stronger correlation between hand dominance and achievement than between hand dominance and subject attitude, as indicated in Tables 8 and 9.

TABLE 8

Correlation of Hand Dominance with Achievement Variables

	ENGLISH FINAL	MATHEMATICS FINAL	SOCIAL STUDIES FINAL	PHYSICAL EDUCATION FINAL	SCIENCE FINAL	OPTIONS FINAL
HAND DOMINANCE	.36***	.32***	.37***	.25**	.30***	.22**

** Significant at P = 0.01
*** Significant at P = 0.001

TABLE 9

Correlation of Hand Dominance with Attitudinal Variables

	ENGLISH ATTITUDE	MATHEMATICS ATTITUDE	READING ATTITUDE	SCIENCE ATTITUDE	SOCIAL ATTITUDE	CAREER PLANNING	CAREER EXPLOR	CAREER DECISION	WORLD OF WORK INFORMATION	OCCUPAO TIONAL KNOWLEDGE	CAREER TOTAL
HAND DOMINANCE	-.07	.26**	.02	-.02	-.11	.05	.12	.18*	.14	.15	.19*

* Significant at P = 0.05
** Significant at P = 0.01

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

This final chapter of the study contains a summary in which the research question, methodology and limitations of the study are discussed, conclusions that were drawn, and implications for schooling, education, and further research.

Summary

The purpose of this study was to compare secondary school left-handed and right-handed writers on selected demographic, attitudinal, and achievement variables. A review of the literature related to left-handedness and the various problems that left-handed people may encounter in both society and school was discussed. Evidence was presented and studies cited to provide information on how handedness is related to demographic, attitudinal, and achievement variables.

Respondents in the study were tenth and eleventh grade students attending Kildonan-East Regional Secondary School, Winnipeg. During visits to the tenth and eleventh grade classrooms, the left-handed writers verbally identified themselves to the researcher.

The population of the left-handed writers consisted of 60 students. At the tenth grade, there were 21 males and seven females for a total of 28. At the eleventh grade, there were 19 males and 13 females for a total of 32.

A random sample of 60 right-handed writers were selected. There were 28 tenth grade and 32 eleventh grade right-handed writers.

The number of right-handed males and females matched the left-handed group.

All individuals in the study were subsequently and individually interviewed by the researcher. Data were collected on demographic variables, attitudinal variables (both student self-expressed and test instrument measured), hand dominance, career development, vocational maturity, and final marks in school.

Hand dominance was measured by using the Harris Tests of Lateral Dominance (1974), and was administered to the entire sample. This test was also used as a means to check the validity of selection of the two main groups of left-handed and right-handed writers.

A questionnaire was designed by the researcher and administered to all students who took part in the study. The questionnaire was divided into two main sections: demographic variables and student self-expressed attitudinal variables.

Measurements of attitudes toward secondary school subjects were determined by using the Secondary form of the Estes Attitude Scales - Measures of Attitudes Toward School Subjects (1981). The Career Development Inventory (1979) was used as a measure of career development and vocational maturity. For each of the students in the study, final school marks were determined by a check of school records. Chi-square, multiple t tests, and correlation tests were used to analyze data.

The results of this study show that the proportion of left-handed male writers is significantly higher than left-handed female writers. Left-handed tenth and eleventh grade male writers outnumbered the left-handed female writers by 66.7 per cent to 33.3 per cent. A large majority (85 per cent) of the right-handed writers were academic

students (arts and science and business education) while over half (51.7 per cent) of the left-handed writers were vocational students.

Left-handed writers are more varied in their handedness. With reference to demographic variables, there were no significant differences between left-handed and right-handed writers with respect to birth order, left-handedness of parents, left-handedness of siblings, participation in extra-curricular activities, and age.

Regarding attitudinal variables, there were no significant differences between left-handed and right-handed writers with respect to liking of school, greatest dissatisfaction with school, and school subjects liked the most. More right-handed than left-handed writers rated themselves as good students. Left-handed writers had more positive attitudes towards social studies, whereas right-handed writers had more positive attitudes towards mathematics. Right-handed writers also had a greater measure of career development and vocational maturity.

With respect to achievement variables there were no significant differences between left-handed and right-handed writers in regards to the school subject they listed as receiving their highest and lowest mark. The right-handed writers consistently received higher final marks in all of the six subject areas. The lowest achievers were the left-handed male writers.

The limitation of the study is that the respondents in the study were selected from one large secondary high school. A larger proportion of subjects would have been more desirable.

The conclusions of this study of the differences between left-handed and right-handed writers with respect to demographic variables are that:

1) The proportion of left-handed male writers is higher than left-handed female writers. There is a connection between sinistrality and gender.

2) The left-handed writer is more apt to be enrolled in a vocational program than an arts and science (academic) program, whereas a right-handed writer is more likely to select an academic program.

3) Left-handed writers are more varied in their handedness than right-handed writers. The left-handed writers in this study exhibited varied sinistral tendencies ranging from "strongly left-handed" to "mixed ambidextrous" tendencies.

4) Right-handed writers are more consistent in their handedness and tend to exhibit strong dextral tendencies.

5) There is a relationship between sex and degree of left-handedness. Left-handed male writers tended to be either strongly left-handed or moderately left-handed. Left-handed female writers tended to be more ambi-dextrous or moderately left-handed, rather than strongly left-handed. Left-handed male writers were more strongly left-handed than left-handed female writers.

6) There were no significant differences between left-handed and right-handed writers with respect to birth order, left-handedness of parents, left-handedness of

siblings, participation in extra-curricular activites and age.

Regarding attitudinal variables, the findings of this study indicated that:

1) Right-handed writers liked school for social reasons, while left-handed writers tended to enjoy school for educational reasons.

2) More right-handed than left-handed writers perceived themselves as being good students.

3) Left-handed writers had a more positive attitude towards social studies than right-handed writers.

4) Right-handed writers had a more positive attitude towards mathematics.

5) Left-handed male writers had a more positive attitude towards the subject of English than right-handed male writers. Right-handed male writers had a more positive attitude towards mathematics than did left-handed male writers.

6) Left-handed male writers had a more positive attitude towards science than left-handed female writers.

7) Right-handed writers had a greater measure of career development and vocational maturity than left-handed writers.

8) There were no significant differences between left-handed and right-handed writers with respect to liking of school, greatest dissatisfaction with school, and school subjects liked the most.

Regarding the achievement variables, the findings supported the following:

1) Right-handed writers scored consistently and significantly higher in all of the six subject areas (English, mathematics, social studies, physical education, science, and options) than did the left-handed writers.
2) Of all the sub-groups, left-handed male writers scored the lowest in all subjects.
3) There were no significant differences between left-handed and right-handed writers with respect to the school subject they listed as receiving their highest and lowest mark.

Implications for Further Research

The implications of this study reside in two areas: 1) school and 2) further research.

This study has found evidence that would support the notion that the sinistral student is at a disadvantage in our school system and, in general, does not perform as well as dextral students. However, it is more than a matter of left- versus right-handedness. It is also an issue of two types of thinking: logical and analogical, and an issue of brain functioning. Evidence shows that the sinistral student is more apt to be right brain orientated than are dextral students. The left hemisphere is dominate for thinking of an analytical, linear nature, while the right hemisphere is dominant for holistic thinking. Most school systems are heavily biased towards left cerebral functioning and are anthithetical to right cerebral functioning. Current patterns of education emphasize the logical and propositionality rather than the

analogical and oppositionality. Sperry (1975) wrote:

> Our education system and modern society generally (with its very heavy emphasis on communication and on early training in the three Rs) discriminates against one whole half of the brain. I refer, of course, to the nonverbal, nonmathematical, minor hemisphere which we find has its own perceptual, mechanical, and spatial mode of apprehension and reasoning. In our present school system, the attention given to the minor hemisphere of the brain is minimal compared with training lavished on the left or major hemisphere.

Perhaps a curriculum which develops right hemisphere abilities is needed. But the question is not whether education should attempt to develop either the left or the right hemisphere, but that it should concentrate upon the development of neurological symmetry. To neglect one in favour of the other is to be pedagogically naive. Learning experiences in schools should be providing opportunities for a balance between the two hemispheres. Education should allow students the ability of expression through each hemisphere. There are instructional and learning strategies which can be applied to activate the lesser used right brain and, thus, involve the whole brain in learning and, thereby, illiciting more rounded learning. There could be enhancement of sensory awareness for exploring non-rational ways of knowing. More emphasis on "hands on" manipulation of materials and "experimental" learning opportunities of how things work. Education should allow students greater opportunity to experiment with a variety of arts and crafts, woodwork, pottery, dance, music, physical education, and drama. The reality in our schools is that these activities have a subordinate status in the curriculum, particularly at the secondary school level. Another way of stimulating right brain thinking is the use of imagery, metaphors, analogies, and similes. They promote

awareness of relationships between dissimilar objects and situations. Poets understand the power of metaphors. Effective education results in a commitment to the functions and enhancement of both cerebral hemispheres. Educators should acknowledge the fullness of the human mind.

It is suggested that further research focus on:

1) In depth interviews of individual students that investigate further the relationship between handedness and the outcome variables.

2) A further study might focus on a larger sample of students in many more secondary schools. The conclusions generated from this one high school should serve as a guide for expanded research.

3) Research could be conducted on a longitudinal basis that might examine and explain when the various differences begin. Do such differences begin at pre-school, elementary, or junior high school levels, or are they unique to the secondary level? This study only examined students at the secondary school level.

4) Additional variables to examine are hobbies, socio-economic level, and socialization as the search for significant variation continues.

REFERENCES

Adams, T. and Awamutu, T. "Left-Handedness and Psychoses". New Zealand Medical Journal, 1978, 88, 296.

Andrews, G., Quinn, P.T., and Sorby, W.A. "Stuttering, An Investigation into Cerebral Dominance for Speech". Journal of Neurology Neurosurgery and Psychiatry, 1972, 35, 414-418.

Annett, M. "A Model of the Inheritance of Handedness and Cerebral Dominance". Nature, 1964, 204, 59-60.

Annett, M. "The Binomial Distribution of Right, Mixed and Left-Handedness". Quarterly Journal of Experimental Psychology, 1967, 19, 327-333.

Annett, M. "A Classification of Hand Preference by Association Analysis". British Journal of Psychology, 1970, 61, 303-321.

Annett, M. "The Growth of Manual Preference and Speed". British Journal of Psychology, 1970, 61, 545-558.

Annett, M. "The Distribution of Manual Asymmetry". British Journal of Psychology, 1972, 63, 343-348.

Annett, M. "Handedness in Families". Annals of Human Genetics, 1973a, 37, 93-105.

Annett, M. "Laterality of Childhood Hemiplegia and the Growth of Speech and Intelligence". Cortex, 1973b, 9, 4-33.

Annett, M. "Handedness in the Children of Two Left-Handed Parents". British Journal of Psychology, 1974, 65, 129-131.

Annett, M. "Hand Preferences and the Laterality of Cerebral Speech". Cortex, 1975, 11, 305-328.

Annett, M. "Family Handedness in Three Generations Predicted by the Right Shift Theory". Annals of Human Genetics, 1979, 42, 479-491.

Annett, M. and Turner, A. "Laterality and the Growth of Intellectual Abilities". British Journal of Educational Psychology, 1974, 44, 37-46.

Applebee, A.N. "Research in Reading Retardation: Two Critical Problems". Journal of Child Psychology and Psychiatry, 1971, 12, 91-113.

Assessment of Career Development. Iowa City, Iowa: The American College Testing Program, 1973.

Asymmetrical Function of the Brain. M. Kinsbourne (Ed.). Cambridge: Cambridge University Press, 1978.

Bailey, R. H. The Role of the Brain. New York: Time-Life Books, 1975.

Bakan, P. "The Eyes Have It". Psychology Today, 1971, 4, 64-67.

Bakan, P. "Handedness and Birth Order". Nature, 1971, 229, 195.

Bakan, P. "Left-Handedness and Alcoholism". Perceptual and Motor Skills, 1973, 36, 514.

Bakan, P., Dibb, G., and Reed, P. "Handedness and Birth Stress". Neuropsychologia, 1973, 11, 363-366.

Bakker, D., Smink, T., and Reitsma, P. "Ear Dominance and Reading Ability". Cortex, 1973, 9, 302-312.

Balow, I.H. "The Relationships of Lateral Dominance Characteristics to Reading Achievement in the First Grade". Journal of Psychology, April 1963, 55, 323-328.

Balow, I.H. and Balow, B. "Lateral Dominance and Reading Achievement in the Second Grade". American Educational Research Journal, May 1964, 1, 139-143.

Barry, R.J. and James, A.L. "Handedness in Autistics, Retardates, and Normals of a Wide Age Range". Journal of Autism and Childhood Schizophrenia, 1978, 8, 3, 315-323.

Barsley, M. Left-Handed People. California: Wilshire Book Co., 1979.

Baty, C.W. and McConnel, J.K. "Two Sides of the Brain in Language and Art". Educational Research, 1976, 18, 3, 201-207.

Benton, A.L. and Kemble, J.D. "Right-Left Orientation and Reading Disability". Psychiatry and Neurology Cases, 1960, 139, 49-60.

Benson, D.F. "Graphic Orientation Disorders of Left-Handed Children". Journal of Learning Disabilities, 1970, 3, 3, 126-131.

Berman, A. "The Problem of Assessing Cerebral Dominance and Its Relationship to Intelligence". Cortex, 1971, 7, 372-386.

Bernstein, J.E., Page, J.C., and Janicki, R.S. "Some Characteristics of Children with Minimal Brain Dysfunction", 1974. In McCormick, D.P. "Right-Left Orientation and Writing Hand in Children Referred for Neurodevelopmental Assessment", Perceptual and Motor Skills, 1978, 46, 1175-1180.

Black, D., Young, C.C., Pei, W.C., and de Chardin, T. "Fossil Man in China". Memoirs of the Geological Survey of China, 1933, Series A, No. 11. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Blackstock, E.G. "Cerebral Asymmetry and the Development of Early Infantile Autism". Journal of Autism and Childhood Schizophrenia, 1978, 8, 3, 339-353.

Blai, B. "Learning Conflict Among Mixed-Dominance Left-Handed Individuals", 1971. (ERIC Document Reproduction Number ED 052474).

Blakeslee, T.R. The Right Brain. New York: PBJ Books Inc., 1983.

Blau, A. "The Master Hand: A Study of the Origins and Meaning of Right and Left Sidedness and its Relation to Personality and Language". Research Monographs, No. 5, p. 206, New York: The American Orthopsychiatric Association, Inc., 1946. As cited in Hicks, R.E. and Kinsbourne, M. "On the Genesis of Human Handedness", Journal of Motor Behavior, 1976, 8, 4, 257-266.

Blau, T.H. "Sinister Psychology". Science News, 1974, 14, 106, 220-222.

Bogen, J.E. "The Other Sdie of the Brain, II: An Appositional Mind". Bulletin of the Los Angeles Neurological Society, 1969, 34, 135-162.

Bogen, J.E. "Some Educational Aspects of Hemispheric Specialization". UCLA Educator, Spring 1975, 17, 2, 24-32.

Boklage, C.E. "Schizophrenia, Brain Asymmetry Development, and Twinning: Cellular Relationship with Etiological and Possible Prognostic Implications". Biological Psychiatry, 1977, 12, 19-35.

Bolin, B.J. "Left-Handedness and Stuttering as Signs Diagnostic of Epileptics". Journal of Mental Science, 1953, 99, 483-488.

Boucher, J. "Hand Preference in Autistic Children and Their Parents". Journal of Autism and Childhood Schizophrenia, 1977, 7, 2, 177-187.

Bradbury, E. "Menelian Heredity in Man". Eugenics Review, 1912, 4, 200-202. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Brain Mechanisms Underlying Speech and Language. C.H. Millikan and F.L. Darley (Eds.). New York: Grune and Stratton, 1967.

Bradshaw, J.T. and Taylor, M.J. "A Word-Naming Deficit in Nonfamilial Sinistrals, Laterality Effects of Vocal Responses to Tashistoscopically Presented Letter Stings". Neuropsychologia, 1979, 17, 21-32.

Branch, C., Milner, B., and Rasmussen, T. "Intracarotid Sodium Amytal for the Lateralization of Cerebral Speech Dominance". Journal of Neurosurgery, 1964, 21, 399-405.

Breton, R. Social and Academic Factors in Career Decisions of Canadian Youth. Ottawa: Information Canada, 1972.

Briggs, G.C., Nebes, R.D., and Kinsbourne, M. "Intellectual Differences in Relation to Personal and Family Handedness". Quarterly Journal of Experimental Psychology, 1976, 28, 591-601.

Brinton, D. "Left-Handedness in North American Aboriginal Art". American Anthropologist, 1896, 9, 175-181.

Brown, G.R. "Handwriting: A State of the Art Research Paper". Winnipeg School Division No. 1, 1977.

Bryden, M.P. "Tachistoscopic Recognition and Cerebral Dominance". Perceptual and Motor Skills, 1964, 19, 686.

Bryden, M.P. "Tachistoscopic Recognition, Handedness, and Cerebral Dominance". Neuropsychologia, 1965, 2, 1-18.

Bryden, M.P. "Laterality Effects in Dichotic Learning: Relations with Handedness and Reading Ability in Children". Neuropsychologia, 1970, 8, 443-450.

Bryden, M.P. "Perceptual Asymmetry in Vision: Relation to Handedness, Eyedness, and Speech Lateralization". Cortex, 1973, 9, 418-432.

Bryden, M.P. "Speech Lateralization in Families: A Preliminary Study Using Dichotic Listening". Brain and Language, 1975, 2, 201-211.

Bryngelson, B. "Sidedness as an Etiological Factor in Stuttering - 700 Cases". Journal of Genetic Psychology, 1935, 47, 1, 204-207.

Burt, C. "Brain and Consciousness". Bulletin of British Psychological Society, 1969, 62, 90-94.

Cerebral Localization. Zulch, K. J., Creutzfeldt, O., and Galbraith, G.C. (Eds.). New York: Springer-Verlag, 1975.

Cerf, A. and Prins, D. 1974. "Stutterers' Ear Preference for Dichotic Syllables". Paper presented to the American Speech and Hearing Association Convention, Las Vegas. As cited in Moore, W.H. Jr. and Weidner, W.E. "Bilateral Tashistoscopic Word Perception in Aphasic and Normal Subjects", Perceptual and Motor Skills, 1974, 38, 1003-1011.

Chakrabartic, J. and Barker, D.G. "Lateral Dominance and Reading Ability". Perceptual and Motor Skills, 1966, 22, 881-882.

Chamberlain, H.D. "Inheritance of Left-Handedness". Journal of Heredity, 1928, 19, 557-559.

Chandler, B.C. and Parson, O.A. "Altered Hemispheric Functioning Under Alcohol". Journal of Studies on Alcohol, 1977, 38, 3, 381-389.

Colby, K.M. and Kraemer, H.C. "An Objective Measurement of Non-Speaking Children's Performance with a Computer-Controlled Program for the Stimulation of Language Behavior". Journal of Autism and Childhood Schizophrenia, 1975, 5, 139-146.

Colby, K.M. and Parkison, C. "Handedness in Autistic Children". Journal of Autism and Childhood Schizophrenia, 1977, 7, 3-9.

Coleman, R.I. and Deutsch, C.P. "Lateral Dominance and Right-Left Discrimination: A Comparison of Normal and Retarded Readers". Perceptual and Motor Skills, 1964, 50, 43-50.

Collins, R.L. "On the Inheritance of Handedness I: Laterality in Inbred Mice". Journal of Heredity, 1968, 59, 9-12.

Collins, R.L. "On the Inheritance of Handedness II: Selection for Sinistrality in Mice". Journal of Heredity, 1969, 60, 117-119.

Collins, R.L. "When Left-Handed Mice Live in Right-Handed Worlds". Science, 1975, 187, 181-184.

Corballis, C. and Beale, I.L. The Psychology of Left and Right. New Jersey: Hillsdale, Lawrence Erhbaum Associates, 1976.

Coren, S. and Porac, C. "Fifty Centuries of Right-Handedness: The Historical Record". Science, 1977, 198, 631-632.

Cramer, E.H. "A Study of the Relationships Among Mental Imagery, Reading Comprehension, and Reading Attitude of Eleventh and Twelfth Grade Students". (Doctoral Thesis, University of Wisconsin, Madison, Wisconsin, 1975). Dissertation Abstracts Internationa - A, 1975-76, 36, 5764A.

Critchley, M. Mirror-Writing. London: Kegan Paul, 1928. As cited in Barsley, M. Left-Handed People, California: Wilshire Book Co., 1979.

Critchley, M. Developmental Dyslexia. London: William Heinemann Medical Books Limited, 1964.

Crites, J.O. Career Maturity Inventory. Monterey, California: California Test Bureau/McGraw-Hill, 1973.

Crites, J.O. Career Counselling: Models, Methods, and Materials. New York: McGraw Hill Book Co., 1981.

Cronbach, L.J. 1951. "Coefficient Alpha and the Internal Structure of Tests". Psychometrika, 16:297-334. As cited in Hopkins, K.D. and Stanley, J.C. Educational and Psychological Measurement and Evaluation, 6th Edition, Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1981.

Croutch, B. "Handwriting and Correct Posture". Academic Therapy, 1969, 4, 283-284.

Curry, F. and Gregory, H. "The Performance of Stutterers on Dichotic Listening Tasks Thought to Reflect Cerebral Dominance". Journal of Speech and Hearing Research, 1969, 12, 78-82.

Dart, R.A. "The Predatory Implemental Technique of Australopithecus". American Journal of Physical Anthropology, 1949, 7, 1-38.

Dawson, J.L.M. "Temne-Arunta Hand-Eye Dominance and Cognitive Style". International Journal of Psychology, 1972, 7, 219-233.

Dearborn, W.F. "Ocular and Manual Dominance in Dyslexia". Psychology Bulletin, 1931, 28, 704. As cited in Hecaen, H. and De Ajuriaguerra, J. Left-Handedness: Manual Superiority and Cerebral Dominance, New York: Grune and Stratton, 1964.

Dearborn, W.F. "Structural Factors Which Condition Special Disability in Reading". Proceedings of the 57th Annual Session of the American Association for Mental Deficiency, 1933, 38, 266-283. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, New Jersey: Hillsdale, Lawrence Erhbaum Associates, Publishers, 1976.

Dennis, W. "Early Graphic Evidence of Dextrality in Man". Perceptual and Motor Skills, 1958, 8, 147-149.

Dewson, J.H., Cowey, A., and Weiskrantz, L. "Disruptions of Auditory Sequence Discrimination by Unilateral and Bilateral Cortical Ablations of Superior Temporal Gyrus in the Monkey". Experimental Neurology, 1970, 28, 529-548.

Dimond, S.J. The Double Brain. London: Churchill Livingstone, 1972.

Domhoff, G.W. "Why Did They Sit On the King's Right". Psychoanalytic Review, 1970, 56, 4, 586-596.

Dulin, K.L. and Chester, R.D. "A Validation Study of the Estes Attitude Scale". Journal of Reading, 1974, 1, 56-59.

Dvirskii, A.E. "Functional Asymmetry of the Cerebral Hemispheres in Clinical Types of Schizophrenia". Neuroscience and Behavioral Physiology, 1976, 7, 236-239.

Eccles, J.C. Brain and Conscious Experience. New York: Springer-Verlag, 1966.

Eccles, J.C. The Understanding of the Brain (2nd Edition). New York: McGraw Hill Book Co., 1977.

Edmonds, E.P. "Psychosomatic Non-Articular Rheumatism". Annals of the Rheumatic Disease, 1947, 6, 36-49.

Enstrom, E.A. "The Relative Efficiency of the Various Approaches to Writing with the Left Hand". Journal of Educational Research, 1962, 55, 573-577.

Estes, T.H., Estes, J.J., Richards, H.C., and Roettger, D.M. Estes Attitude Scales: Measures of Attitudes Towards School Subjects. Austin, Texas: Pro-Ed Services, 1981.

Estes, T.H., Estes, J.J., Richards, H.C., and Roettger, D.M. Estes Attitude Scales: Measures of Attitudes Towards School Subjects, Manual for Administration and Interpretation. Austin, Texas: Pro-Ed Services, 1981.

Ettlinger, G. "Lateral Preferences in the Monkey". Nature, 1964, 204, 606.

Fagan-Dubin, L. "Spatial Perception in Normal and Psychotic People". Perceptual and Motor Skills, 1978, 47, 799-802.

Felek, A. "Handedness: A Family Study". American Journal of Human Genetics, 1959, 11, 52-62.

Finch, G. "Chimpanzees' Handedness". Science, 1941, 94, 117-118.

Fitzhugh, K. "Some Neuropsychological Features of Delinquent Subjects". Perceptual and Motor Skills, 1973, 36, 494.

Fleminger, J.J., De L. Horne, D.J., and Nott, P. "Unilateral Electro-convulsive Therapy and Cerebral Dominance: Effect of Right- and Left-Sided Electrode Placement on Verbal Memory". Journal of Neurology, Neurosurgery, and Psychiatry, 1970, 33, 408-411.

Fleminger, J.J., Dalton, R., and Standage, K.F. "Handedness in Psychiatric Patients". British Journal of Psychiatry, 1977, 131, 448-452.

Fleminger, J.J., Dalton, R., and Hsu, G. "Lateral Response to Suggestions in Relation to Handedness". Perceptual and Motor Skills, 1978, 46, 1344-1346.

Flick, G.L. "Sinistrality Revisited: A Perceptual-Motor Approach". Child Development, 1966, 37, 613-622.

Flor-Henry, P. "Gender, Hemispheric Specialization and Psycho-pathology". Social Science and Medicine, 1978, 12B, 155-162.

Flor-Henry, P. and Koles, Z.J. "Studies in Right/Left Hemispheric Energy Oscillations in Schizophrenia, Mania, Depression, and Normals". Psychopharmacology Bulletin, 1980, 16, 4, 52-53.

Foeschels, E. "Is Handedness Organic or Functional in Nature?" American Journal of Psychotherapy, 1961, 15, 101-105.

Foerster, L.M. "Sinistral Power! Help for Left-Handed Children". Elementary English, 1975, 52, 213-215.

Forness, S.R. and Weil, M.C. "Laterality in Retarded Readers with Brain Dysfunction". Exceptional Children, 1970, 36, 9, 684-685.

Fox, P.L. "Reading as a Whole Brain Function". Reading Teacher, 1979-80, 33, 1, 7-14.

Freeman, F.N. "Teaching Handwriting - What Research Says to the Teacher", (No. 4), 1954, Washington, D.C. "National Education Association. As cited in Brown, G.R. "Handwriting: A State of the Art Research Paper", Winnipeg School Division No. 1, 1977.

Galin, D., Diamond, R., and Braff, D. "Lateralization of Conversion Symptoms: More Frequent on the Left". American Journal of Psychiatry, 1977, 134, 578-580.

Gates, A.I. and Bond, G.L. "Reading Readiness, A Study of Factors Determining Success and Failure in Beginning Readers". Teacher's College Record, 1936, 37, 679-685. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, New Jersey: Hillsdale, Lawrence Erhbaum Associates, Publishers, 1976.

Gazzaniga, M.S. "Review of the Split Brain". UCLA Educator, Spring 1975, 17, 2, 9-12.

Geschwind, M. and Behan, P. "Left-Handedness, Learning Disorders, and Autoimmunity". Proceedings of the National Academy of Sciences, U.S.A., 1982, As cited in Marx, J.L. "Autoimmunity in Left-Handers", Science, 1982, July 9, 141-144.

Gilbert, C. "Strength of Left-Handedness and Facial Recognition Ability". Cortex, 1973, 9, 145-151.

Gloning, I., Gloning, K., Haub, G., and Quatember. "Comparison of Verbal Behavior in Right-Handed and Non-Right-Handed Patients with Anatomically Verified Lesions of One Hemisphere". Cortex, 1969, 5, 41-52.

Goodglass, H. and Quadfasel, F.A. "Language Laterality in Left-Handed Aphasics". Brain, 1954, 77, 521-548.

Gordon, H. "Left-Handedness and Mirror Writing Especially Among Defective Children". Brain, 1920, 43, 313-368. As cited in Nagylaki, T. and Levy, J. "The Sound of One Paw Clapping Isn't Sound", Behavior Genetics, 1973, 3, 279-292.

Groff, P.J. "Who Writes Faster". Education, 1963, 83, 367-369.

Groff, P.J. "Who are the Better Writers - the Left-Handed or the Right-Handed?" Elementary School Journal, 1964, 65, 92-96.

Groves, C.P. and Humphrey, N.K. "Asymmetry in Gorilla Skulls: Evidence of Lateralized Brain Function?" Nature, 1973, 244, 53-54.

Guilford, J.P. and Fruchter, B. Fundamental Statistics in Psychology and Education, 6th Edition, New York: McGraw Hill Book Company, 1978.

Gulliksen, H. and Voneida, T. "An Attempt to Obtain Replicate Learning Curves in the Split Brain Cat". Physiological Psychology, 1975, 3, 77-85.

Gur, R.E., Gur, R.C., and Harris, L.J. "Hemispheric Activation, as Measured by the Subjects' Conjugate Lateral Eye Movements, is Influenced by Experimenter Location". Neuropsychologia, 1975, 13, 35-44.

Gur, R.E. "Motoric Laterality Imbalance in Schizophrenia". Achieves of General Psychiatry, 1977, 34, 33-37.

Gur, R.E. "Left Hemisphere Dysfunction and Left Hemisphere Overactivation in Schizophrenia". Journal of Abnormal Psychology, 1978, 87, 2, 226-238.

Gur, R.E., Gur, R.C., Obrist, W., Hungerbukler, J.P., Skolnick, B., and Reivick, M. "Sex and Handedness Differences in Cerebral Blood Flow During Rest and Cognitive Activity". Science, August 13, 1982, 217, 659-660.

Halliday, J.L. "Psychological Factors in Rheumatism: A Preliminary Study". British Medical Journal, 1937, February 6, 264-269.

Halliday, J.L. The Concept of Psychosomatic Rheumatism". Annals of Internal Medicine, 1941, 15, 666-677.

Hansen, E. "Reading and Writing Difficulties in Children With Cerebral Palsy". As cited in Bax, M.C. and MacKeith, R.C. (Editors). Minimal Cerebral Dysfunction, Philadelphia: Spastics International Medical Publication, 1963, 58-61.

Hanvik, L.J. and Kaste, C.M. "Mixed Cerebral Dominance in Clinic and School Populations". Perceptual and Motor Skills, 1973, 37, 900-902.

Hardyck, C. and Petrinovich, L.F. "Left-Handedness". Psychological Bulletin, 1977, 84, 3, 385-404.

Harris, A.J. "Lateral Dominance, Directional Confusion, and Reading Disability". Journal of Psychology, 1957, 44, 283-294.

Harris, A.J. Harris Tests of Lateral Dominance - Manual of Directions for Administration and Interpretation, 3rd Edition, New York, Psychological Corporation, 1974.

Harris, L.J. "Functional Specialization of the Cerebral Hemisphere in Infants and Children: New Experimental and Clinical Evidence". Paper presented at the Bitennial Meeting of the Society for Research in Child Development, Denver, Colorado, April 13, 1975. (ERIC Document Reproduction Number ED 118271).

Hart, L.A. How the Brain Works. New York: Basic Books Inc., Publishers, 1975.

Hartlage, L.C. and Green, J.B. "EEG Differences in Children's Reading, Spelling, and Arithmetic Abilities". Perceptual and Motor Skills, 1971, 32, 133-134.

Hauser, S.L., DeLong, R., and Rosman, M.P. "Pneumographic Findings in the Infantile Autism Syndrome". Brain, 1975, 98, 667-688.

Hecaen, H. and Piercy, M. "Paxorysmal Dysphasia and the Problem of Cerebral Dominance". Journal of Neurology, Neurosurgery, and Psychiatry, 1956, 19, 194-201.

Hecaen, H. and Sauguet, J. "Cerebral Dominance in Left-Handed Subjects". Cortex, 1971, 7, 19-48.

Hecaen, H. and De Ajuriaguerra, J. Left-Handedness: Manual Superiority and Cerebral Dominance. New York: Grune and Stratton, 1964.

Hemisphere Function in the Human Brain. Dimond, S.J. and Beaumont, S.G. (Editors). New York: Halstead Press, 1974.

Herron, J. "Southpaws - How Different Are They?" Psychology Today, 1976, March, 50-56.

Hicks, R.E. and Barton, A.K. "A Note on Left-Handedness and Severity of Mental Retardation". Journal of Genetic Psychology, 1975, 127, 323-324.

Hicks, R.E. and Kinsbourne, M. "Human Handedness: A Partial Cross-Fostering Study". Science, 1976a, 192, 908-910.

Hicks, R.E. and Kinsbourne, M. "On the Genesis of Human Handedness". Journal of Motor Behavior, 1976b, 8, 4, 257-266.

Hicks, R.E. and Kinsbourne, M. "Human Handedness". In Asymmetrical Function of the Brain. M. Kinsbourne (Editor), Cambridge: Cambridge University Press, 1978.

Higginbottam, J.A. "Relationships Between Sets of Lateral and Perceptual Preference Measures". Cortex, 1973, 9, 403-410.

Hildreth, G. "The Development and Training of Hand Dominance. Part I - 1949". Genetic Psychology, 75, 197-220.

Hines, D. "Bilateral Tachistoscopic Recognition of Verbal and Non-Verbal Stimuli". Cortex, 1972, 7, 313-322.

Hines, D. and Satz, P. "Superiority of Right Visual Half-Fields in Right Handers for Recall of Digits Presented at Varying Rates". Neuropsychologia, 1971, 9, 21-25.

Hines, D. and Satz, P. "Cross-Modal Asymmetries in Perception Related to Asymmetry in Cerebral Function". Neuropsychologia, 1974, 12, 239-247.

Hopkins, K.D. and Stanley, J. Educational and Psychological Measurement and Evaluation. 6th Edition, Englewood Cliffs, New Jersey: Prentice Hall Inc., 1981.

Hudson, P.T.W. "The Genetics of Handedness: A Reply to Levy and Nagylaki". Neuropsychologia, 1975, 13, 331-339.

Hunter, M. "Right-Brained Kids in Left-Brained Schools". Today's Education, 1976, 64, 4, 45-58.

Ingram, T.T.S. "Pediatric Aspects of Specific Developmental Dysphasia, Dyslexia, and Dysgraphia". Cerebral Palsy Bulletin, 1960, 2, 254-277.

Ingram, T.T. and Reid, J.F. "Developmental Aphasia Observed in a Department of Child Psychiatry". Archives of Disease in Childhood, 1956, 31, 161-172. As cited in Mackworth, J.F. "Cerebral Laterality and Reading", 1976. Paper presented at the Conference on Theory and Practice of Beginning Reading Instruction. University of Pittsburgh, Learning Research and Development Centre. (ERIC Document Reproduction Number ED 155652).

Ingvar, D. "Functional Landscapes of the Dominant Hemisphere". Brain Research, 1976, 107, 181-197.

Interhemispheric Relations and Cerebral Dominance. Mountcastle, V.B. (Editor). Baltimore: John Hopkins Press, 1961.

Isom, J.B. "Neurological Research Relevant to Reading - 1967". U.S. Department of Health, Education, and Welfare, Office of Education. (ERIC Document Reproduction Number ED 012 223).

Jackson, J. "A Survey of Psychological, Social, and Environmental Differences Between Advanced and Retarded Readers". Journal of Genetic Psychology, 1944, 65, 113-131. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, New Jersey: Hillsdale, Lawrence Erhbaum Associates, Publishers, 1976.

James, W.E., Mefferd, R.B., and Wieland, B.A. "Repetitive Psychometric Measures: Handedness and Performance". Perceptual and Motor Skills, 1967, 25, 209-212.

Jasper, H.H. "A Laboratory Study of Diagnostic Indices of Bilateral Neuromuscular Organization in Stutterers and Normal Speakers". Psychological Monographs, 1932, 43, 72-174.

Johnstone, J.P. "Convergent and Discriminant Validity of A Scale to Measure Attitudes Toward School Subjects". Doctoral Thesis, University of Virginia, Charlottesville, Virginia, 1974. Ann Arbor Michigan University Microfilms, 1974, No. 73 - 32. As cited in Estes, T.H., Estes, J.J., Richards, H.C., and Roettger, D.M. Estes Attitude Scales: Measures of Attitudes Towards School Subjects,

Manual for Administration and Interpretations. Austin, Texas: Pro-Ed Services, 1981.

Jones, E. The Use of Visual Training and Postural Remediation With Groups of College Students. Los Angeles: University of California Press, 1967.

Jones, B.M. "Verbal and Spatial Intelligence in Short and Long Term Alcoholics". Journal of Nervous and Mental Disease, 1971, 153, 4, 292-297.

Jones, B.M. and Parsons, O.A. "Impaired Abstracting Ability in Chronic Alcoholics". Archives of General Psychiatry, 1971, 24, 71-75.

Jones, R.K. "Observations on Stammering After Localized Cerebral Injury". Journal of Neurology, Neurosurgery, and Psychiatry, 1966, 29, 192-195.

Jordaan, J.P. and Heyde, M.B. Vocational Maturity During High School Years. New York: Teacher's College Press, Columbia University, 1979.

Jordan, H.E. "The Inheritance of Left-Handedness". American Breeder's Magazine, 1911, 2, Nos. 1,2. As cited in Hardyck, C. and Petrinovich, L.R. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Jordan, H.E. "Heredity Left-Handedness with a Note on Twinning". Journal of Genetics, 1914, 4, 67-81. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Kaufman, A.S., Zalma, R., and Kaufman, N. "The Relationship of Hand Dominance to the Motor Coordination, Mental Ability, and Right-Left Awareness of Young Normal Children". Child Development, 1978, 49, 885-888.

Keeney, A.H. and Keeney, E. 1968. National Conference on Dyslexia, Philadelphia. "Dyslexia-Diagnosis and Treatment of Reading Disorders". St. Louis: Mosley.

Kenyon, F.E. "Hypochondriasis: A Clinical Study". British Journal of Psychiatry, 1964, 110, 478-488.

Kimura, D. "Cerebral Dominance and the Perception of Verbal Stimuli". Canadian Journal of Psychology, 1961, 15, 166-171.

Kinney, M.C. "Teaching Handwriting - A Teacher's Guide to Developing Skills in Handwriting", 1964, 34, Regina, Saskatchewan: School Aids and Text Book. In Brown, G.R. "Handwriting: A State of the Art Research Paper", Winnipeg School Division No. 1, 1977.

Kinsbourne, M. "Eye and Head Turning Indicates Cerebral Lateralization". , Science, 1972, 1976, 539-541.

Klisz, D.K. and Parsons, O.A. "Ear Asymmetry in Reaction Time Tasks as a Function of Handedness". Neuropsychologia, 1975, 13, 323-330.

Komai, T. and Fukuoka, G. "A Study on the Frequency of Left-Handedness and Left-Footedness Among Japanese School Children". Human Biology, 1934, 6, 33-42.

Kovarsky, V. "Comment Apparait le Begaiement Chez Un Enfant Gaucher Contrarie Oto-Rhino-Larying". Internat, 31, 27-29, 1947. As cited in Hecaen, H. and De Ajuriaguerra, J. Left-Handedness: Manual Superiority and Cerebral Dominance. New York: Grune and Stratton, 1964.

Krashen, S.D. "The Left Hemisphere". UCLA Educator, 1975, (Spring), 17, 2, 17-23.

Lake, D.A. and Bryden, M.P. "Handedness and Sex Differences in Hemispheric Asymmetry". Brain and Language, 1976, 3, 266-282.

Levy, J. "Possible Basis for the Evolution of Lateral Specialization of the Human Brain". Nature, 1969, 224, 614-615.

Levy, J. and Nagylaki, T. "A Model for the Genetics of Handedness". Genetics, 1972, 72, 117-128.

Levy, J. "Psychobiological Implications of Bilateral Asymmetry". In Dimond, J.J. and Beaumont, J.G. (Editors). Hemispheric Function in the Human Brain. New York: Halstead Press, 1974.

Lewis, E.R. "An Analysis of Children's Manuscript Handwriting". Dissertation Abstracts, 1964, 25, 3, 1786-1787.

Lieben, B. "Analysis of Results of the Harris Tests of Hand Dominance Used as Group Tests". Unpublished Master's Thesis, Library of the City College of New York, New York, New York, 1951. As cited in Harris, A.J. Harris Tests of Lateral Dominance - Manual of Directions for Administration and Interpretation, 3rd Edition, New York: Psychological Corporation 1974.

Lishman, W.A. and McKeekan, E.R.C. "Hand Preference Patterns in Psychiatric Patients". British Journal of Psychiatry, 1976, 129, 158-166.

Lishman, W.A. and McKeekan, E.R.C. "Handedness in Relation to Direction and Degree of Cerebral Dominance for Language". Cortex, 1977, 13, 30-43.

Lomas, J. and Kirmura, D. "Intrahemispheric Interaction Between Speaking and Sequential Manual Activity". Neuropsychologia, 1976, 14, 23-33.

Luessenhop, A.J., Boggs, J.S., La Borwit, L.J., and Eugene, L.W. "Cerebral Dominance in Stutters Determined by Wada Testing". Neurology, 1973, 23, 1190-1192.

Luria, A.R. "Tarumatic Aphasia: Its Syndromes, Psychopathology, and Treatment". Moscow: Academy of Medical Sciences, 1969. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, New Jersey: Hillsdale, Lawrence Erhbaum Associates, Publishers, 1976.

Lutz, K.A. "The Implication of Brain Research for Learning Strategies and Educational Practice". 1978. (ERIC Document Reproduction Number ED 163068).

Luzzetti, A.J. "Selected Characteristics of Sixth Grade Students as Related to Their Reading Performance". (Doctoral Thesis, Lehigh University, Bethlehem, Pennsylvania, 1974). Dissertation Abstracts International - A, 1974-1975, 35, 6942A.

McCormick, D.P. "Right-Left Orientation and Writing Hand in Children Referred for Neurodevelopmental Assessment". Perceptual and Motor Skills, 1978, 46, 1175-1180.

McDonald, A. Jr. "Differences Between High Ability Underachieving Students in Relation to Self-Concept, Anxiety, and Lateral Dominance". (Doctoral Thesis, University of Maryland, College Park, 1964). Dissertation Abstracts, 1965-1966, 26, 1, 200.

McFie, J. "Cerebral Dominance in Cases of Reading Disability". Journal of Neurology, Neurosurgery and Psychiatry, 1952, 15, 194-199.

McGee, M. "Laterality, Hand Preference, and Human Spatial Ability". Perceptual and Motor Skills, 1976, 42, 781-782.

McGlone, J. and Davidson, W. "The Relation Between Cerebral Speech Laterality and Spatial Ability with Special Reference to Sex and Hand Preference". Neuropsychologia, 1973, 11, 105-113.

McKeever, W.F. and Hurling, M.D. "Bilateral Tachistoscopic Word Recognition as a Function of Hemisphere Stimulation and Inter-hemispheric Transfer Time". Neuropsychologia, 1971a, 9, 291-299.

McKeever, W.F. "Lateral Dominance in Tachistoscopic Word Recognition Performances Obtained with Simultaneous Bilateral Input". Neuropsychologia, 1971b, 9, 15-20.

McKeever, W.F., Suberi, M., and Van Deventer, A.D. "Fixation Control in Tachistoscopic Studies of Laterality Effects: Comments and Data Relevant to Hines' Experiment". Cortex, 1972a, 8, 473-479.

McKeever, W.F. and Van Deventer, A.D. "Visual and Auditory Language Processing Asymmetries: Influences and Handedness, Familial Sensuality, and Sex". Cortex, 1972b, 13, 255-241.

McKeever, W.F. and Van Deventer, A.D. "Familial Sinistrality and Degree of Left-Handedness". British Journal of Psychology, 1977a, 68, 469-471.

McKeever, W.F. and Van Deventer, A.D. "Failure to Confirm a Spatial Ability Impairment in Persons with Evidence of Right Speech Capability". Cortex, 1977b, 13, 321-326.

McRae, D.L., Branch, C.L., and Milner, B. "The Occipital Horns and Cerebral Dominance". Neurology, 18, 95-98.

Mackworth, J.F. "Cerebral Laterality and Reading", 1976. Paper presented at the Conference on Theory and Practice of Beginning Reading Instruction. University of Pittsburgh, Learning Research and Development Centre. (ERIC Document Reproduction Number ED 155652).

Magorin, H.W. "Discussion of Brain Mechanisms in Speech". In Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Marx, J.L. "Autoimmunity in Left-Handers". Science, 1982, July 9, 141-144.

Mason, O.T. "Throwing Sticks". American Anthropologist, 1896, 9, 226.

Mefferd, R.B., Lester, J.W., Wieland, D.A., Falconer, G.A., and Pokarny, A.D. "Influence of Distraction on the Reproduction of Spoken Words by Schizophrenia". Journal of Nervous and Mental Disease, 1969, 149, 504-509.

Merskey, H. and Spear, F.G. "Pain: Psychological and Psychiatric Aspects", 1967. As cited in Stern, D.B. "Handedness and the Lateral Distribution of Conversion Reactions". Journal of Nervous and Mental Disease, 1977, 164, 2, 122-128.

Miller, E. "Handedness and the Pattern of Human Ability". British Journal of Psychology, 1971, 62, 1, 111-112.

Mintz, A. "Lateral Preferences of a Group of Mentally Subnormal Boys". Journal of Genetic Psychology, 1947, 71, 75-84.

Moore, W.H. Jr. and Weidner, W.E. "Bilateral Tachistoscopic Word Perception in Aphasic and Normal Subjects". Perceptual and Motor Skills, 1974, 38, 1003-1011.

Moore, W.H. Jr. "Bilateral Tachistoscopic Word Perception of Stutterers and Normal Subjects". Brain and Language, 1976, 3, 434-442.

Morley, M.E. The Development and Disorders of Speech in Childhood, (3rd Edition), Edinburgh: Churchill Livingstone, 1972.

Muehl, S. "Relation Between Word-Recognition Errors and Hand-Eye Preference in Preschool Children". Journal of Educational Psychology, 1963, 54, 316-321.

Murphy, M.M. "Hand Preferences of Three Diagnostic Groups of Severely Deficient Males". Perceptual and Motor Skills, 1962, 14, 508.

Nagylaki, T. and Levy, J. "The Sound of One Paw Clapping Isn't Sound". Behavior Genetics, 1973, 3, 279-292.

Nebes, R.D. "Handedness and the Perception of Part-Whole Relationships". Cortex, 1971, 7, 350-356.

Nebes, R.D. "Hemispheric Specialization in Commissurotomized Man". Psychological Bulletin, 1974, 81, 1-14.

Nebes, R.D. and Briggs, G.G. "Handedness and the Retention of Visual Material". Cortex, 1974, 10, 209-214.

Nebes, R.D. "Man's So-Called 'Minor' Hemisphere". UCLA Educator, 1975 (Spring), 17, 2, 13-16.

Newcombe, E.F. and Ratcliffe, G. "Handedness, Speech Lateralization, and Ability". Neuropsychologia, 1973, 11, 399-407.

Newman, H.H. "Differences Between Conjoined Twins: In Relation to a General Theory of Twinning". Journal of Heredity, 1931, 22, 201-207. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Newman, H.H. "Multiple Human Births". Doubleday, Doran, and Co., New York, 1940. As cited in Nagylaki, T. and Levy, J. "The Sound of One Paw Clapping Isn't Sound". Behavior Genetics, 1973, 3, 279-292.

New York City Board of Education. "Teaching Handwriting". Curriculum Bulletin No. 3, 1960-1961, Series 42. As cited in Brown, G.R. "Handwriting: A State of the Art Research Paper", Winnipeg School Division No. 1, 1977.

New York Times News Service. "More Perils Face Left-Handers, New Studies Show". Winnipeg Free Press, April 21, 1983.

Noll, U.H. and Scannell, D.P. Introduction to Educational Measurement. 3rd Edition, Boston: Houghton Mifflin Co., 1972.

Offord, D.R. "The Natural Histories of Schizophrenia, Depression, Disorders, and Psychopathy: Current Status". Psychosomatics, 1971, 12, 179.

Oddy, H.C. and Lobstein, J.J. "Hand and Eye Dominance in Schizophrenia". British Journal of Psychiatry, 120, 1972, 331-332.

Ohlendorf, P. "Left-Handers are Not all Gauche". Macleans, August 2, 1982, 46-47.

Oldfield, R.C. "The Assessment and Analysis of Handedness - The Edinburgh University". Neuropsychologia, 1971, 9, 97-113.

Orlando, C.P. "Relationships Between Language, Laterality, and Handedness in Eight and Ten Year Old Boys". (Doctoral Thesis, University of Connecticut, Storrs, 1971). Dissertation Abstracts International - A, 1971-1972, 32, 5, 248 9A.

Orme, J.E. "Left-Handedness, Ability, and Emotional Instability". British Journal of Social and Clinical Psychology, 1970, 9, 87-88.

Ornstein, R.E. The Psychology of Consciousness (2nd Edition). New York: Harcourt Brace Jovanovich, Inc., 1977.

Orton, S.T. "Studies in Stuttering". Archieves of Neurology and Psychiatry. 1927, 18, 671-672.

Orton, S.T. "A Physiological Theory of Reading Disability and Stuttering in Children". New England Journal of Medicine, 1929, 199, 1046-1052.

Orton, S.T. Reading, Writing, and Speech Problems in Children. New York: W.W. Norton and Co., Inc., 1937.

Otto, W. and McMenemy, R.A. Corrective and Remedial Teaching. Boston: Houghton Mifflin, 1966.

Paivio, A. Imagery and Verbal Processes. New York: Holt-Rinehart and Winston, 1971. As cited in Mackworth, J.F. "Cerebral Laterality and Reading", 1976. Paper presented at the Conference on Theory and Practice of Beginning Reading Instruction. University of Pittsburgh, Learning Research and Development Centre. (ERIC Document Reproduction Number ED 155652).

Palmer, R.D. "Hand Differentiation and Psychological Functioning". Journal of Personality, 1963, 31, 445-461.

Perrin, K.L. and Eisenson, J. 1970. An examination of ear preference for speech and non-speech stimuli in a stuttering population. Paper presented at the Annual Convention of the American Speech and Hearing Assocation, New York. As cited in Moore, W.H. Jr. and Weidner, W.E. "Bilateral Tachistoscopic Word Perception in Aphasic and Normal Subjects". Perceptual and Motor Skills, 1974, 38, 1003-1011.

Porac, C. and Coren, S. Lateral Preferences and Human Behavior. New York: Springer-Verlag, 1981.

Pratt, R.T., Warrington, E.K., and Halliday, A.M. "Unilateral ECT as a Test for Cerebral Dominance with a Strategy for Treating Left-Handers". British Journal of Psychiatry, 1971, 119, 78-83.

Pratt, R.T. and Warrington, E.K. "The Assessment of Cerebral Dominance with Unilateral ECT". British Journal of Psychiatry, 1972, 121, 327-328.

Prins, D. and Walton, W. 1971. "Effects of Monaural and Binaural DAF Upon the Speech of Stutterers in Relation to Responses in a Dichotic Listening Task". Paper presented at the Annual Convention, Chicago. As cited in Moore, W.H. Jr. and Weidner, W.E. "Bilateral Tachistoscopic Word Perception in Aphasic and Normal Subjects". Perceptual and Motor Skills, 1974, 38, 1003-1011.

Quinn, P.T. "Stuttering, Cerebral Dominance, and the Dichotic Word Test". Medical Journal of Australia, 1972, 2, 639-643.

Quinan, C. "The Principal Sinistral Types: An Experimental Study, Particularly as Regards Their Relation to the So-Called Psychopathic States". Archives of Neurology and Psychiatry, 1930, 24, 35-47.

Raina, M. "Education of the Left and the Right". International Review of Education, 1979, 25, 7-20.

Ramaley, F. "Inheritance of Left-Handedness". American Naturalist, 1912, 46, 730-738. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Ramaley, F. "Mendelian Proportions and the Increase of Recessives". American Naturalist, 1913, 47, 334-339. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness". Psychological Bulletin, 1977, 84, 3, 385-404.

Ramos, R. "Left-Handed Writing". 1970. In Brown, G.R. "Handwriting: A State of the Art Research Paper", Winnipeg School Division No. 1, 1977.

Rasmussen, K.J. and Milner, B. 1975. "Clinical and Surgical Studies of the Cerebral Speech Areas in Man". As cited in Hicks, R.E. and Kinsbourne, M. "Human Handedness". In Asymmetrical Function of the Brain, M. Kinsbourne (Editor). Cambridge: Cambridge University Press, 1978.

Rasmussen, T. and Milner, B. "The Role of Early Left-Brain Injury in Determining Lateralization of Cerebral Speech Functions". In Evolution and Lateralization of the Brain. Dimond, J. and Blizzard, D. (Editors). New York: New York Academy of Sciences, 1977.

Reed, G.F. and Smith, A.C. "A Further Experimental Investigation of the Relative Speeds of Left- and Right-Handed Writers". Journal of Genetic Psychology, 1962, 100, 275-288.

Regelski, T.A. "Who Knows Where Music Lurks in the Mind of Man?" Music Educators Journal, 1977, 63, 9, 31-38.

Rennels, M.R. "Help - My Eyes Are Melting". Viewpoints, 1976, 52, 3, 63-73.

Restak, R.M. The Brain: The Last Frontier. New York: Warner Books, 1980.

Rhead, J.C. and Fischer, R. "Man's Two Cerebral Hemispheres and Their Implication for Psychotherapy". In McCabe, O.L. (Editor), Changing Human - Current Therapies and Future Directions. New York: Grune and Stratton, 1977.

Rhoads, J.G. and Damon, A. "Some Genetic Traits in Solomon Island Populations". American Journal of Physical Anthropology, 1973, 39, 179-183.

Rife, D.C. "Handedness with a Special Reference to Twins". Genetics, 1940, 25, 178-186.

Rife, D.C. "An Application of Gene Frequency Analysis to the Interpretation of Data from Twins". Human Biology, 1950, 22, 136-145.

Riklan, M. and Levita, B. "Psychological and Electronencephalographic Relationships and Cryothalemectomy for Parkinsononism". Perceptual and Motor Skills, 30, 1970, 799-810.

Robinson, J.S. and Voneida, T.J. "Hemisphere Differences in Cognitive Capacity in the Split-Brain Cat". Experimental Neurology, 1973, 38, 123-134.

Rodale, J.I. The Synonym Finder. Pennsylvania: Rodale Press, Inc., 1978.

Roget, P.M. Roget's International Thesaurus, 4th Edition. Revised by Robert L. Chapman. New York: Thomas Y. Crowell Co., 1977.

Roget, P.M. Roget's Thesaurus of English Words and Phrases. Lloyd S. M. (Editor). Essex: Longman Group Limited, England, 1982.

Rosanoff, A.J., Handy, L.M., and Plesset, I.R. "The Etiology of Mental Deficiency with Special Reference to its Occurrence in Twins". Psychological Monographs, 1937, 48, 216. As cited in Nagylaki, T. and Levy, J. "The Sound of One Paw Clapping Isn't Sound", Behavior Genetics, 1973, 3, 279-292.

Rossi, G.F. and Rosandini, G. "Experimental Analysis of Cerebral Dominance in Man". In Millikan, C.H. and Darley, F.L. (Editors). "Brain Mechanisms Underlying Speech and Language", New York: Grune and Stratton, 1967.

Roudinesco, Mme. and Thyss, J. "L'Enfant Gaucher. Etudo Clinique; Signification Physiologique; Problemes Pedagogiques". Enfance 1, 8-29, 126-141, 1948. As cited in Hecaen, H. and De Ajuriaguerra, J. Left-Handedness: Manual Superiority and Cerebral Dominance, New York: Grune and Stratton, 1964.

Sagan, C. The Dragons of Eden. Toronto: Random House, Inc., 1977.

Sale, G. The Koran - Translated into English From the Original Arabic. London: Frederick Warne and Co., Ltd., 1927.

Samples, B. "Educating for Both Sides of the Human Brain". Science Teacher, 1975, 42, 1, 21-48.

Sank, D. and Firschein, B.D. "Fingerprints and Laterality Preferences of Early-Onset Autism". Birth Defects : Original Article Series, 1979, Vol. 15, No. 6, 679-695. The National Foundation.

Satz, P., Achenbach, K., Patteshall, E., and Fennell, E. "Order of Report, Ears Asymmetry, and Handedness in Dichotic Listening". Cortex, 1965, 1, 377-396.

Satz, P. "Pathological Left-Handedness: An Explanatory Model". Cortex, 1972, 8, 121-135.

Satz, P. "Left-Handedness and Early Brain Insult: An Explanation". Neuropsychologia, 1973, 11, 115-117.

Satz, P. and Silva, D. "Pathological Left-Handedness: Evaluation of a Model". Brain and Language, 1979, 7, 8-16.

Sax, G. Principles of Educational and Psychological Measurement and Evaluation. 2nd Edition, Belmont, California: Wadsworth Publishing Corp., 1980.

Schacter, M. "Left-Handed and Right-Handed Persons". Pediatrics, 1970, 45, 499.

Schneeberger De Ataide; Contribuicao para O estudo da assimetria funcional dos hemishpferios cerebrais. A Crianco Portuguesa 1: 107-108, 1951. As cited in Hecaen, H. and De Ajuriaguerra, J. Left-Handedness: Manual Superiority and Cerebral Dominance, New York: Grune and Stratton, 1964.

Schott, A. "Left-Handedness and Heredity". Zeitschrift fur die Gesamte Neurologie und Psychiatrie, 1931, 135, 1-322. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Schwartz, H.A. "Cerebral Organization, Handedness, and Education". Academic Therapy, 1980, 16, 1, 95-100.

Silver, A.A. and Hagin, R.A. "Specific Reading Disability: Delineration and Relationship to Cerebral Dominance". Comprehensive Psychiatry, 1, 2, 126-134. As cited in Isom, J.B. "Neurological Research Relevant to Reading 1967". U.S. Department of Health, Education, and Welfare; Office of Education. (ERIC Document Reproduction Number ED 012223).

Silverman, A.J., Adenai, G., and McGough, W.E. "Some Relationships Between Handedness and Perception". Journal of Psychosomatic Research, 1966, 10, 151-158.

Slater, E. "Hysteria". Journal of Mental Science, 1961, 107, 359.

Smokler, I.A. and Shevrin, H. "Cerebral Lateralization and Personality Style". Archives of General Psychiatry, 1979, 36, 949-954.

Sommers, R.K., Brady, W., and Moore, W.H. Jr. "Dichotic Ear Preferences of Stuttering Children and Adults". Perceptual and Motor Skills, 1975, 41, 931-938.

Sparrow, S.S. and Satz, P. "Dyslexia, Laterality, and Neuropsychological Development". Specific Reading Disability. Rotterdam: University Press, 1970, 41-60.

Sperry, R. "Left Brain, Right Brain". Saturday Review, August 1975, 33.

Stern, D.B. "Handedness and the Lateral Distribution of Conversion Reactions". Journal of Nervous and Mental Disease, 1977, 164, 2, 122-128.

Summers, E.G. "Instruments for Assessing Reading Attitudes: A Review of Research and Bibliography". Journal of Reading Behavior, 1978, 9, 137-165.

Super, D.E. "A Theory of Vocational Development". American Psychologist, 1953, 8, 185-190.

Super, D.E. The Psychology of Careers. New York: Harper and Row, 1957.

Super, D.E., Crites, J.O., Hummel, R.C., Moser, H.P., Overstreet, P.L., and Warnath, C.F. Vocational Development. New York: Teacher's College Press, Columbia University, 1957.

Super, D.E. and Overstreet, P.L. The Vocational Maturity of Ninth-Grade Boys. New York: Teacher's College Press, Columbia University,, 1960.

Super, D.E., Starishevsky, R., Mathlin, N., and Jordaan, J.P. Career Development: Self-Concept Theory. New York: Teacher's College Press, Columbia University, 1963.

Super, D.E. and Bohn, M.J. Jr. Occupational Psychology. Belmont, California: Wadsworth Publishing Company, Inc., 1970.

Super, D.E. Measuring Vocational Maturity for Counselling and Evaluation. Washington, D.C.: National Vocational Guidance Association Monography, 1974.

Super, D.E., Thompson, A.S., Lindeman, R.H., Jordaan, J.P., and Myers, R.A. Career Development Inventory. Palo Alta, California: Consulting Psychological Press, Inc., 1979.

Sussman, H.M. and MacNeilage, P.F. "Hemispheric Specialization for Speech Production and Perception in Stutterers". Neuropsychologia, 1975a, 13, 19-26.

Sussman, H.M. and MacNeilage, P.F. "Studies on Hemispheric Specialization for Speech Production". Brain and Language, 1975b, 2, 131-151.

Swerdloff, P. Men and Women. New York: Time-Life Books, 1975.

Taylor, D.C. and Ounstead, C. "Biological Mechanisms Influencing the Outcomes of Seizures in Response to Fever". Epilepsia, 1971, 12, 33.

Taylor, D.C. "Factors Influencing the Occurrence of Schizophrenia-like Psychoses in Patients with Temporal Lobe Epilepsy". Psychological Medicine, 1975, 5, 249.

Taylor, P.F., Dalton, R., and Fleminger, J.J. "Handedness in Schizophrenia". British Journal of Psychiatry, 1980, 136, 375-383.

Thass-Thienemann, T. "Left-Hand Writing: A Study in the Psychoanalysis of Language". Psychoanalytic Review, 1955, 42, 239-261.

Thompson, A.S. and Lindeman, R.H. Career Development Inventory, User's Manual. Palo Alta, California: Consulting Psychologists Press, Inc., 1981.

Thomson, M.E. "A Comparison of Laterality Effects in Dyslexics and Controls Using Verbal Diachotic Listening Tasks". Neuropsychologia, 1976, 14, 243-246.

Trankell, A. Vansterhanthei hos born i Skolaldern, Helsinki, Finland: Forum, 1950. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness". Psychological Bulletin, 1977, 84, 3, 385-404.

Trankell, A. "Aspects of Genetics in Psychology". American Journal of Human Genetics, 1955, 7, 264-276. As cited in Hardyck, C. and Petrinovich, L.F. "Left-Handedness", Psychological Bulletin, 1977, 84, 3, 385-404.

Travis, L.E. Speech Pathology, 1931, New York: Appleton - Century - Crofts. As cited in Moore, W.H. Jr. and Weidner, W.E. "Bilateral Tachistoscopic Word Perception in Aphasic and Normal Subjects". Perceptual and Motor Skills, 1974, 38, 1003-1011.

Travis, L.E. and Lindsley. "An Action Current Study of Handedness in Relation to Stuttering". Journal of Experimental Psychology, 1933, 16, 258-269.

Tsai, L. and Maurer, S. "Right-Handedness in White Rats". Science, 1930, 72, 436-438.

Verhaegen, O. and Ntumba, A. "A Note on the Frequency of Left-Handedness in African Children". Journal of Educational Psychology, 1964, 55, 89-90.

Vernon, M.D. Backwardness in Reading (2nd Edition). Cambridge: University Press, 1960. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, New Jersey: Hillsdale, Lawrence Erhbaum Associates, Publishers, 1976.

Wada, J. "A New Method of the Determination of the Side of Cerebral Speech Dominance. A Preliminary Report on the Intracarotid Injection of Sodium Amytal in Man". Medicine and Biology, 1949, 14, 221-222.

As cited in Branch, C., Milner, B., and Rasmussen, T. "Intracarotid Sodium Amytal for the Lateralization of Cerebral Speech Dominance". Journal of Neurosurgery, 1964, 21, 399-405.

Wada, J. and Rasmussen, T. "Intracarotid Injection of Sodium Amytal for the Lateralization of Cerebral Speech Dominance: Experimental and Clinical Observation". Journal of Neurosurgery, 1960, 17, 266-282.

Wada, J., Clark, R., and Hamm, A. "Cerebral Hemispheric Asymmetry in Humans". Archives of Neurology, 1975, 32, 239-246.

Wahl, O.F. "Handedness in Schizophrenia". Perceptual and Motor Skills, 1976, 42, 944-946.

Wall, W.D. "Reading Backwards Among Men in the Army. I". British Journal of Educational Psychology, 1945, 15, 28-40. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, Lawrence Erhbaum Associates, Publishers, Hillsdale, New Jersey, 1976.

Wall, W.D. "Reading Backwardness Among Men in the Army. II". British Journal of Educational Psychology, 1946, 16, 133-148. As cited in Corballis, C. and Beale, I.L. The Psychology of Left and Right, Lawrence Erhbaum Associates, Publishers, Hillsdale, New Jersey, 1976.

Warrington, E.K. and Pratt, R.T.C. "Language Laterality in Left Handers Assessed by Unilateral ECT". Neuropsychologia, 1973, 11, 423-428.

Webster's Third New International Dictionary of the English Language. Unabridge, 1977. Gove, P.M., Editor in Chief. Massachusetts: G. and C. Merriam Co., Publishers, Springfield.

Weigel, R.G. "Laterality, Mirror-Writing, and Mirror-Reading". Perceptual and Motor Skills, 1971, 32, 969-970.

Weiner, G., Rider, R.V., Oppel, W.C., Fisher, L.K., and Harper, P.A. "Correlates of Low Birth Weight". Pediatrics, 1965, 35, 434-444.

Wildon, M.O. and Donlan, L.B. "Handedness and Ability". American Journal of Psychology, 1931, 43, 261-268.

Wingate, M.E. Stuttering: Theory and Treatment. New York: Irvington, 1976.

Witelson, S.F. "Developmental Dyslexia: Two Right Hemispheres and None Left". Science, 1977, 195, 309-311.

Witelson, S.F. and Rabinovitch, M.S. "Hemispheric Speech Lateralization in Children with Auditory Linguistic Deficits". Cortex, 1972, 8, 412-426.

Wittrock, M.C. "The Generative Processes of Memory", 1975. As cited in Mackworth, J.F. "Cerebral Laterality and Reading", 1976. Paper presented at the Conference on Theory and Practice of Beginning

Reading Instruction. University of Pittsburgh, Learning Research, and Development Centre. (ERIC Document Reproduction Number ED 155652).

World Almanac and Book of Facts - 1983. Lane, H.U. (Editor). Published for the Winnipeg Free Press by Newspaper Enterprise Association Inc., New York, New York.

Wussler, M. and Barclay, A. "Cerebral Dominance Psycholinguistics Skills and Reading Disability". Perceptual and Motor Skills, 1970, 31, 419-425.

Yen, W. "Independence of Hand Preference and Sex-Linked Genetic Effects on Spatial Performance". Perceptual and Motor Skills, 1975, 41, 1, 311-318.

Young, J.Z. "Why Do We Have Two Brains?" In Mountcastle, V.B. (Editor). Interhemispheric Relations and Cerebral Dominance. Baltimore: John Hopkins Press, 1961.

Zangwill, O.L. Cerebral Dominance and Its Relation to Psychological Function. Edinburgh: Oliver and Boyd, 1960.

Zangwill, O.L. "Speech and the Minor Hemisphere". Acta Neurologica Psychiat. Belgica. 1967, 67, 1013-1020.

Zangwill, O.L. "Handedness and Dominance". In Hicks, R.E. and Kinsbourne, M. "On the Genesis of Human Handedness". Journal of Motor Behavior, 1976, 8, 4, 257-266.

Zurif, E.B. and Bryden, M.P. "Familial Handedness and Left-Right Differences in Auditory and Visual Perception". Neuropsychologia, 1969, 7, 179-187.

Zurif, E.B. and Carson, G. "Dyslexia in Relation to Cerebral Dominance and Temporal Analysis". Neuropsychologia, 1970, 8, 351-362.

APPENDIX A

DEMOGRAPHICAL AND SCHOOL RELATED VARIABLES QUESTIONNAIRE

QUESTIONNAIRE

NAME: _____ SEX: _____

PROGRAM OF STUDIES: _____

1. Birth order: (please circle one only) Are you:

   First Born Third Born Fifth Born

   Second Born Fourth Born Sixth Born

   Twin Born

2. Which of your parents are left-handed (please circle):

   Mother Father None

3. Do you have any brothers or sisters (please circle one):

   Yes No

4. Name your brothers and sisters who are left-handed: None (please circle):

   _____ _____

   _____ _____

5. Which of the following activities in school do you participate in outside of your school subjects (please circle):

   Grad Committee Lettermans Cheerleaders

   Yearbook Intramural Sports School Plays

   Physical Sports School Newspaper Other: (Please explain)

6. In general, do you like school (explain):

QUESTIONNAIRE (Cont'd.)

7. In general do you dislike school (explain):

8. In your opinion, how would you rate yourself as a student (please circle only one):

a) Top 10 per cent b) Top 25 per cent

c) Top 50 per cent d) Lowest half

e) Lowest 25 per cent f) Lowest 10 per cent

9. What do you like best about school:

10. What do you dislike most about school:

11. List the school subjects you like the best:

12. List the school subjects you dislike the most:

13. List the school subjects you get the highest marks in:

14. List the school subjects you get the lowest marks in:

APPENDIX B

LETTER OF INTENT

Dear:

RE: Letter of Intent

I am conducting a research project and study as part of my Masters' Thesis in the Faculty of Education, University of Manitoba. The study will compare left-handed writers with right-handed writers in the tenth and eleventh grades.

The purpose of the project is to determine whether there is a significant difference between left-handed and right-handed writers in school grades and performance, career maturity, and attitudes toward school and subjects. Such information is virtually non-existent.

There will be a certain amount of testing done during school time. Permission to do this has been received from Mr. McMaster, the school Principal. The tests used will be:

1) The Career Development Inventory
2) The Estes Attitude Scale
3) The Harris Test of Handedness

I must stress that all comparisons are made on a group basis and at no time will there be any individual comparisons. All responses <u>are strictly confidential</u> and will not be used in any form or method detrimental to the students.

I am most sincerely requesting your cooperation. If there are any questions or concerns, please contact me at the following numbers: School 667-2960 or Home

Thank you.

Barry Wolfe
Counselling Services

I give my permission for my son/daughter to participate_____.

I do not give my permission for my son/daughter to participate _____.

Parent(s) Signature_____, _____.

APPENDIX C

THE HARRIS TESTS OF LATERAL DOMINANCE

THE HARRIS TESTS OF LATERAL DOMINANCE

Record Blank

Name.....Age.....Date.....Examiner.....

1. Knowledge of Left and Right
R hand..... L ear..... R eye.....

HAND DOMINANCE

2. Hand Preferences R.....%
.1 Throw a ball .....
.2 Wind a watch .....
.3 Hammer a nail .....
.4 Brush teeth .....
.5 Comb hair .....
.6 Turn door knob .....
.7 Hold eraser .....
.8 Use scissors .....
.9 Cut with knife .....
.10 Write .....

3. Simultaneous Writing
No. of Reversals:
R..... L..... .....
Co-ordination better: .....

4. Handwriting
Time: R..... L.....
Co-ordination better: .....

5. Tapping
Number: R..... L.....
Co-ordination better: .....

6. Dealing Cards
Time: R..... L.....
Co-ordination better: .....

7. Strength of Grip (optional)
R..... L..... R..... L.....

EYE DOMINANCE

8. Monocular Tests
.1 Kaleidoscope .....
.2 Telescope .....
.3 Sight rifle
Eye .....
Shoulder .....

9. Binocular Tests
.1 Cone: ....
.2 Hole: ....

10. Stereoscopic Tests (optional)
.1 Teleb: R.....% L.....% Supp?.....

FOOT DOMINANCE

11.1 Kick
Pref..... Other..... Better.....

11.2 Stamp
Foot used.....

RATINGS

Test

1 KNOWLEDGE OF LEFT AND RIGHT
: :
Confused Hesitant Normal

HAND DOMINANCE
: : : :
L L M R R

2 : : : :
L L M R R

3 : : : :
L L M R R

4 : : : :
L L M R R

5 : : : :
L L M R R

6 : : : :
L L M R R

7 : : : :
L L M R R

EYE DOMINANCE
: : : :
L L M R R

8 : : : :
L L M R R

9 : : : :
L L M R R

10 : : : :
L L M R R

FOOT DOMINANCE
11 : : : :
L L M R R

11.1 : : : :
L L M R R

11.2 : : : :

Family Background:

Conversion:

Qualitative Comments:

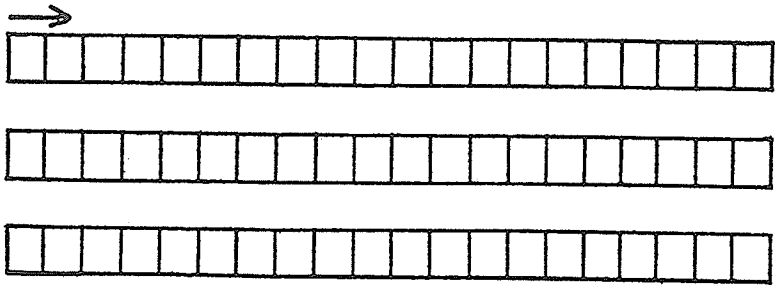
SIMULTANEOUS WRITING

Left *Right*

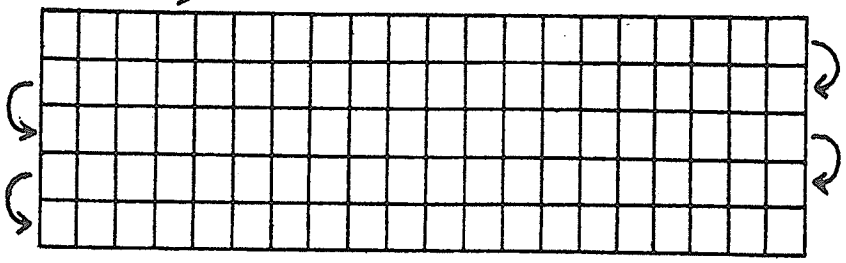
Name..... Hand..... Time..... sec.

Name..... Hand..... Time..... sec.

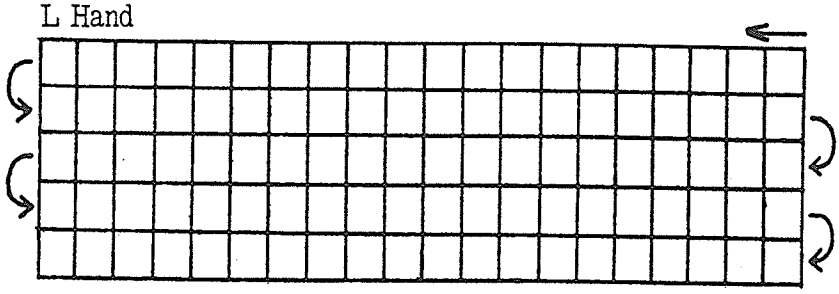
TAPPING

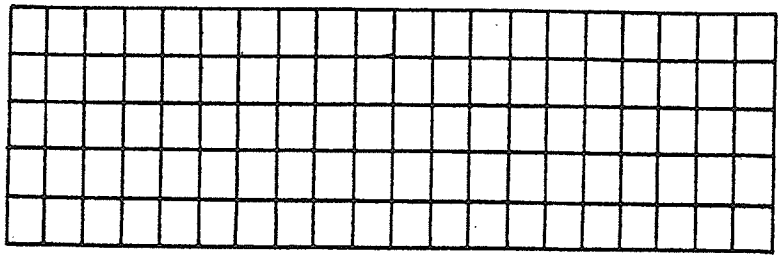


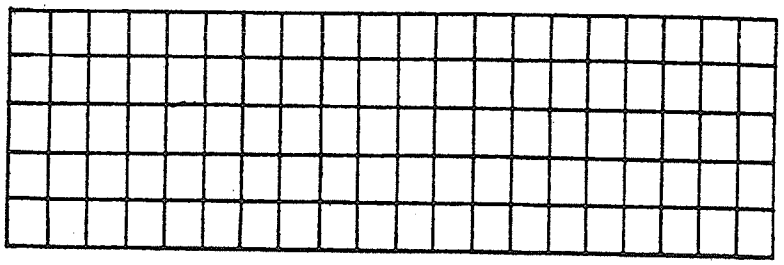
R Hand →



L Hand







Distributed by

THE PSYCHOLOGICAL CORPORATION

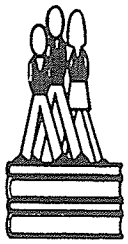
304 East 45th Street

New York, N. Y. 10017

APPENDIX D

ESTES ATTITUDE SCALES

ESTES ATTITUDE SCALES



(Secondary Form)

DIRECTIONS: These scales measure how you feel about courses taught in school. On the front and back of this sheet are statements about school subjects. Read each statement and decide how you feel about it. Rate each statement on a scale of 1 to 5, as follows:

5 will mean "I strongly agree"
4 will mean "I agree"
3 will mean "I cannot decide"
2 will mean "I disagree"
1 will mean "I strongly disagree"

Use the separate answer sheet to indicate your feeling toward each statement. Show your answers by putting an X in the proper box. Please be as honest as possible in rating each statement. Your ratings will not affect your grade in any course.

English

1. Work in English class helps students do better work in other classes.
2. The study of English is a waste of time.
3. Writing papers for English class is good practice.
4. Almost any subject is better than English.
5. English courses are some of the worst courses.
6. Studying English is less tiring than studying other subjects.
7. English is a subject with very little real value.
8. English is boring.
9. Studying English in college would be valuable.
10. Students should be required to take English every year.
11. Most literature is dull.
12. English is fun.
13. Time spent in English class is time well spent.
14. English is one class I can do without.
15. English class is too short.

Mathematics

16. People who like math are often weird.
17. Working math problems is fun, like solving a puzzle.
18. It is easy to get tired of math.
19. Working math problems is a waste of time.
20. Studying math in college would be a good idea.
21. Being able to add, subtract, multiply, and divide is all the math the average person needs.
22. It is impossible to understand math.
23. Even though there are machines to work math problems, there is still a reason to study math.
24. Math is boring.
25. Only mathematicians need to study math.
26. Knowledge of math will be useful after high school.
27. Without math courses, school would be a better place.
28. A student would profit from taking math every year.
29. Math is easy.
30. Math is doing the same thing over and over again.

Continued ⧫

Reading

31. Reading is for learning but not for enjoyment.
32. Spending allowance on books is a waste of good money.
33. Reading is a good way to spend spare time.
34. Books are a bore.
35. Watching T.V. is better than reading.
36. Reading is rewarding to me.
37. Books aren't usually good enough to finish.
38. Reading becomes boring after about an hour.
39. Most books are too long and dull.
40. There are many books which I hope to read.
41. Books should only be read when they are assigned.
42. Reading is something I can do without.
43. Some part of summer vacation should be set aside for reading.
44. Books make good presents.
45. Reading is dull.

Science

46. Field trips in science are more fun than those in other school subjects.
47. An understanding of how the earth changes helps make a better world.
48. Studying science is a waste of time.
49. A deeper love of nature comes from the study of science.
50. There is too much memory work in science.
51. Science is interesting.
52. Science classes are usually fun.
53. Science courses are worth the time and effort they take.
54. Cutting up animals in class is silly.
55. It is fun to figure out how things work.
56. Books about science are boring.
57. Many good hobbies come from the study of science.
58. Science teaches people to think.
59. Students should not be required to take science courses.
60. Exploring outer space may prove useful to mankind.

Social Studies

61. Much of what is taught in social studies is not important.
62. There is too much to worry about in the present for us to worry about the past.
63. Knowledge of the past helps us understand the present.
64. Social studies teachers are usually good teachers.
65. Social studies is the same year after year.
66. The study of history in college would be a good choice.
67. Social studies courses should not be required courses.
68. Social studies is dull.
69. Studying the history of different people of the world helps us understand them.
70. A student can often use what he learns in a social studies course.
71. Man profits little from the study of the past.
72. Social studies is interesting.
73. Social studies has little to offer the average student.
74. Almost any course is better than a social studies course.
75. If social studies changes, it is from bad to worse.

ESTES ATTITUDE SCALES

(Secondary Form)

Thomas H. Estes, Julie Johnstone Estes
Herbert C. Richards, Doris Roettger

	Yr.	Mo.	Day
Date Tested	____	____	____
Date of Birth	____	____	____
Age	____	____	____

M ☐ F ☐

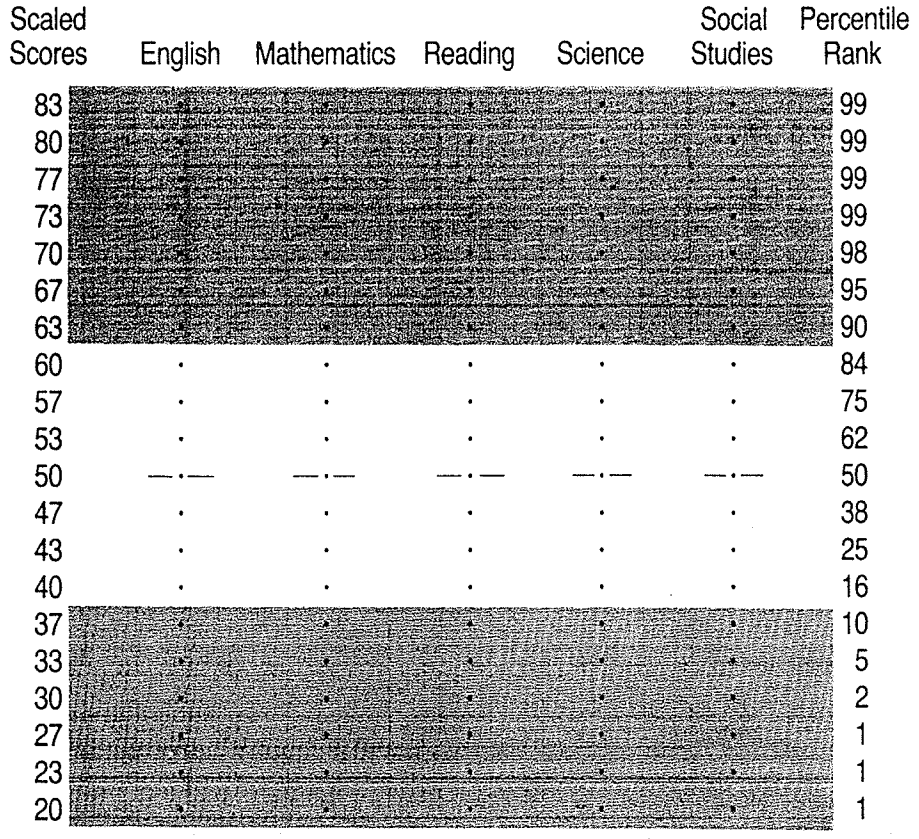
Name _____ Grade _____

School _____ Teacher _____

Examiner's Name _____ and Title _____

Score Summary

	Raw Score	Scaled Score	Percentile Rank
I. English	_____	_____	_____
II. Mathematics	_____	_____	_____
III. Reading	_____	_____	_____
IV. Science	_____	_____	_____
V. Social Studies	_____	_____	_____



ESTES ATTITUDE SCALES

(Secondary Answer Sheet)

English

	Strongly Agree	Agree	Cannot Decide	Disagree	Strongly Disagree
1	5	4	3	2	1
2	5	4	3	2	1
3	5	4	3	2	1
4	5	4	3	2	1
5	5	4	3	2	1
6	5	4	3	2	1
7	5	4	3	2	1
8	5	4	3	2	1
9	5	4	3	2	1
10	5	4	3	2	1
11	5	4	3	2	1
12	5	4	3	2	1
13	5	4	3	2	1
14	5	4	3	2	1
15	5	4	3	2	1

TOTAL _____

Mathematics

	Strongly Agree	Agree	Cannot Decide	Disagree	Strongly Disagree
16	5	4	3	2	1
17	5	4	3	2	1
18	5	4	3	2	1
19	5	4	3	2	1
20	5	4	3	2	1
21	5	4	3	2	1
22	5	4	3	2	1
23	5	4	3	2	1
24	5	4	3	2	1
25	5	4	3	2	1
26	5	4	3	2	1
27	5	4	3	2	1
28	5	4	3	2	1
29	5	4	3	2	1
30	5	4	3	2	1

TOTAL _____

Reading

	Strongly Agree	Agree	Cannot Decide	Disagree	Strongly Disagree
31	5	4	3	2	1
32	5	4	3	2	1
33	5	4	3	2	1
34	5	4	3	2	1
35	5	4	3	2	1
36	5	4	3	2	1
37	5	4	3	2	1
38	5	4	3	2	1
39	5	4	3	2	1
40	5	4	3	2	1
41	5	4	3	2	1
42	5	4	3	2	1
43	5	4	3	2	1
44	5	4	3	2	1
45	5	4	3	2	1

TOTAL _____

Science

	Strongly Agree	Agree	Cannot Decide	Disagree	Strongly Disagree
46	5	4	3	2	1
47	5	4	3	2	1
48	5	4	3	2	1
49	5	4	3	2	1
50	5	4	3	2	1
51	5	4	3	2	1
52	5	4	3	2	1
53	5	4	3	2	1
54	5	4	3	2	1
55	5	4	3	2	1
56	5	4	3	2	1
57	5	4	3	2	1
58	5	4	3	2	1
59	5	4	3	2	1
60	5	4	3	2	1

TOTAL _____

Social Studies

	Strongly Agree	Agree	Cannot Decide	Disagree	Strongly Disagree
61	5	4	3	2	1
62	5	4	3	2	1
63	5	4	3	2	1
64	5	4	3	2	1
65	5	4	3	2	1
66	5	4	3	2	1
67	5	4	3	2	1
68	5	4	3	2	1
69	5	4	3	2	1
70	5	4	3	2	1
71	5	4	3	2	1
72	5	4	3	2	1
73	5	4	3	2	1
74	5	4	3	2	1
75	5	4	3	2	1

TOTAL _____