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THE DEBILITATING EFFECTS OF CERTAIN CLASSROOM PARAPHERNALIA ON THE PSYCHOMOTOR PERFORMANCE OF ADULTS

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EARL GENE GARRISON

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APPROVED BY

DISSERTATION COMMITTEE

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CHAPTER I

INTRODUCTION AND PROBLEM

There can be little doubt that we live in a right-handed world made by right-handed people to accommodate right-handed persons. This is probably the way it should be since only about 12-13 percent of the total population is left-handed (Williams, 1964). At the same time, some provision should be made for those who are left-handed, since they can have special difficulties when attempting to perform certain tasks (Freeman, 1960). This is especially true with educational paraphernalia such as right-handed desks, right-handed pencil sharpeners, and right-handed drinking fountains (Enstrom, 1962b).

In a right-dominant world the left-dominant adult seems to be at a distinct disadvantage. This is especially true, it seems, for the left-dominant adult learner in the traditional classroom. Such debilitating effects can be minimized however, after students have become accustomed to the paraphernalia being used (Ojemann, 1930). The debilitating effects of classroom paraphernalia can be compounded for students of crossed laterality (right-eyed and left-handed or left-eyed and right-handed). Boos and Hillerich (1968) compared the effects of eye dominance and eye control on reading achievement. They found that as students grew

older the adverse effects of left-handedness decrease, but the debilitating effects of crossed laterality remain constant.

The results of this and other studies give rise to many questions. How much debilitating effect does classroom paraphernalia have on psychomotor performance? (Most studies have been concerned with academic performance.) Should debilitating effects caused by classroom paraphernalia exist in relation to psychomotor performance, what other factors should be considered in trying to isolate the cause of the debilitation? If such a debilitating effect exists, is it compounded by crossed laterality? Are such debilitating effects a function of age or experience? It would seem that adaptation to classroom paraphernalia would be more closely related to the amount of classroom experience than to age. These and many ancillary issues are the questions which were considered in the present experiment.

Hypotheses Tested in the Study

In the present study, the stated purposes were accomplished by testing the null propositions of the following hypotheses:

Ho_1 There is no statistically significant difference among the right-handed desk/left-handed desk difference times calculated for the right-handed, left-handed, and crossed-laterality adults.

Ho_2 There is no statistically significant difference among the amounts of time the three groups needed to complete the coding task while seated in the right-handed chair.

Ho_3 There is no statistically significant difference among the amounts of time the right-handed, left-handed, and crossed-laterality adults needed to complete the coding task while seated in the left-handed chair.

Statement of the Problem

The problem of the present study was to investigate the debilitating effects of certain classroom paraphernalia on the psychomotor performance of adults. More specifically, the problem was to determine the debilitating effects of having adults with unilaterality and crossed-laterality sit in left-handed and right-handed desks while performing a speed test of psychomotor performance. The speed test was to determine the debilitating effects being experienced as a result of having to work from a classroom desk which was inappropriate for their laterality (handed/eyedness) orientation. The speed test was coding of the alphabet in reverse order. By comparing the differences in the amount of time needed to complete the task under each condition, the experimenter was able to determine the amount of debilitating effect being experienced by each group of adults.

Statement of the Purpose

The purpose of this research study is to contribute

additional knowledge in adult education by trying to ascertain whether the left-dominant adult experiences any debilitating effects by living in a right-dominant world.

Definitions of Terms

It was necessary to define several terms used in the present study. The following definitions and explanations were offered in order to avoid multiple interpretations of terms.

Adult: A theoretical definition of the term 'adult' according to Jensen (1964)". . . is a person who has come into that stage of life in which he has assumed responsibility for himself and usually for others, and who has concomitantely accepted a functionally productive role in his community."

An operational definition of the term 'adult' as it applies to the present study is those individuals who participated in the study who were enrolled in and attending adult education classes at the Gordon Cooper Area Vocational-Technical School at Shawnee, Oklahoma during the Fall Semester of 1975-76 school year.

Left-Handed Adult/Left-Dominant Adult: Those adults who participated in the study; who were enrolled in and attending adult education classes at the Gordon Cooper Area Vocational Technical School at Shawnee, Ok.,

during the Fall Semester of the 1975-76 school year; and who were classified as left-handed according to their responses to the questionnaire presented in appendix A and left-eyed from their responses to the Hole-in-Card Test shown in appendix B.

Right-Handed Adults: Those adults who participated in the study; who were enrolled in and attending adult education classes at the Gordon Cooper Area Vocational Technical School at Shawnee, Oklahoma during the Fall Semester of the 1975-76 school year; and who were classified as right-handed according to their responses to the questionnaire presented in appendix A and right-eyed from their responses to the Hole-in-Card Test shown in appendix B.

Crossed-Laterality Adults: Those adults who participated in the study; who were enrolled in and attending adult education classes at the Gordon Cooper Area Vocational Technical School at Shawnee, Oklahoma during the Fall Semester of the 1975-76 school year; and who were classified as left-handed and right-eyed or right-handed and left-eyed according to their responses to the questionnaire presented in appendix A and their

responses to the Hole-in-Card Test shown in appendix B.

Paraphernalia/Classroom Paraphernalia: The right- and left-handed classroom (chairs) desks which were used in the experimental study.

Left-Handed Desks/Chairs: Those individual student desks having the arm rest and writing surface on the left side which were used in the experimental study.

Right-Handed Desks/Chairs: Those individual student desks having the arm rest and writing surface on the right side which were used in the experimental study.

Compatible Orientation Tasks: Those coding tasks performed by left-handed adults seated in left-handed desks and those tasks performed by the right-handed adults seated in right-handed desks.

Incompatible Orientation Tasks: Those coding tasks performed by left-handed adults seated in right-handed desks, those coding tasks performed by crossed-laterality adults seated at either desk.

Compatible Orientation Data: The actual time (in seconds) needed to reverse code the alphabet as a compatible orientation task.

Incompatible Orientation Data: The actual time

(in seconds) needed to reverse code the alphabet as an incompatible orientation task.

Debilitating Effects/Debilitating Effects Data: The arithmetic differences between the Compatible Orientation Data and the Incompatible Orientation Data.

Reverse Coding of the Alphabet: The experimental task performed by the study participants. This task required the adults to start with the letter "Z" and code the alphabet in reverse order as quickly as possible ending with the letter "A."

Right-Handed Coding Time: The amount of time (in seconds) needed by the right-handed, left-handed, and crossed-laterality adults to complete the coding task while seated in the right-handed chair.

Left-Handed Coding Time: The amount of time (in seconds) needed by the right-handed, left-handed, and crossed-laterality adults to complete the coding task while seated in left-handed chair.

Difference Time: The arithmetic difference between the right-handed coding time and the left-handed coding time.

Limitations of the Experimental Study

The following limitations were placed on the present study in order to make it possible.

The population of adults was limited to twenty-five (N=25) right-handed with a mean age of 34.30 years of which 42% were male and 58% female; twenty-five (N=25) left-handed, with a mean age of 31.82 years of which 69% were male and 31% female; and twenty-five (N=25) crossed-laterality, with a mean age of 30.58 years of which 56% were male and 44% were female. The three groups of adults were enrolled and attending adult education classes at Gordon Cooper Area Vocational-Technical School at Shawnee, Oklahoma, during the fall semester of the 1975-76 school year.

The experimental tasks performed were limited to those compatible and incompatible orientation tasks performed by the right-handed, left-handed, and crossed-laterality students.

CHAPTER II

REVIEW OF RELATED RESEARCH

Left-handedness is a phenomenon which has continued to perplex behavioral scientists in spite of the sophisticated experimental and statistical methods used to study its occurrence. A conservative estimation is that 10-12 percent of the population is left-handed. Yet, very little provision is made in any aspect of our society to accommodate the left-handed person. Business equipment such as typewriters, telephones, copiers, dictating equipment, and postage meters are designed with the right-handed person in mind. Educational equipment and facilities are also designed for the right-handed teacher and student. This can be a distinct disadvantage to left-handed students at the elementary levels although there seems to be some adjustment to such inconveniences as the students advance (Ferguson, 1971). The inconvenience of educational equipment and facilities is only part of the problem experienced by left-handed students.

The connotations generally associated with left-handedness can seriously affect the young child's self concept, and cause his academic achievement to suffer (Boos & Hillerich, 1968).

Connotations Associated with Left-Handedness

Almost every society has perceived left-handedness in a derogatory way (Clark, 1957). As a result, such terms as "southpaw," "cack-handed," "lefty," and "courier-fisted" are equated with being left-handed. Such terms are epitomized in the English language where the term "sinister" means". . . left-handed; on or to the left-hand side." (Webster, 1974). These connotations have been carried on for centuries in spite of the fact that some of the most notable, respected, and intelligent persons have been left-handed.

Education and educators have done very little to promote the acceptance of left-handed children as being "normal." In fact, most left-handed students recall at least one prolonged attempt made by their teachers to force them to learn to write with their right hand (Johnson, 1964). The negative effects of such actions can be very devastating to the young child, especially during the early stages of self-concept and personality development (Jensen, 1966).

Educators in general and teachers in particular have acquired their concepts and practices of teaching left-handed students from the early theories of left-handedness. The unscientific and sometimes crude attempts to explain handedness have been transmitted from one generation to another. Some of the more prominent theories are presented in the following sections.

Attempts to Explain Left-Handedness

It was not until the nineteenth century that men began to attempt an explanation of left-handedness. Prior to this time left-handedness was regarded as resulting from an accident, faulty training, or an abnormality in bodily structure.

One of the first attempts to explain left-handedness was the Primitive Warfare Theory of Thomas Carlyle (Clark, 1957), in which he contended that men fought with their right hand and covered their heart(protection) with the left.

Buchanan (1862) proposed a Center of Gravity Theory in which he contended that the body's center of gravity caused one to be right-handed.

A third theory, The Eye Dominance Theory, was proposed by Parson (1924). He contended that hand dominance was caused from eye dominance, but his theory was refuted when crossed-laterality was observed.

Wilson (1891) and Humphry (1861) contended that Education was the cause of right-handedness, because of the manner in which books were written and the right-to-left progression of student writing. Their theory was refuted, however, when it was discovered that left-handedness was as common among the illiterate as among those who had attended schools.

Another theory of left-handedness was proposed by Burt (1937) and Blau (1946). They contended that

right-handedness was a normal adjustment, and that left-handedness was a form of negativism and revolt against society.

Further theories of hand preference suggested that one side of the brain was dominant resulting in right or left-handedness, and others studied sinistrality as an inherited characteristic.

None of these theories has proved to be satisfactory although there is considerable evidence that left-handedness is inherited (Newman, Freeman, & Holzinger, 1937). The results of genetic studies may be summarized by saying that genetic studies have revealed that the development of handedness preference has a heredity basis, in other words, one's chances of being left-handed are greater if there are instances of left-handedness in the family.

Left-Handedness and Writing Problems

Children were not always allowed to use their left-hand for writing in school although they showed a definite preference for the left-hand (Johnson, 1937). Many adults changed to the use of their left-hand after leaving school, however, and had little difficulty in making the adjustment.

Such treatment in schools did not come about entirely as the personal preferences of educators. There

were definite problems associated with left-handed writing such as the left-hand smearing the ink of newly written words, punching the pen or pencil through the paper because of the slant of the writing instrument, and the awkward posture assumed by most left-handed writers. Three of the most common incorrect writing positions are shown in figure 1.

An illustration of the correct position for writing with the left-hand is shown in figure 2.

It is a common characteristic among left-handed students that they can never develop as much speed and efficiency in writing as right-handed students (Hurt, 1964). This is probably because of left-to-right progression of the written words is more compatible to the right-handed student. At the same time, part of the left-handed students inefficiency may be caused by his awkward writing position.

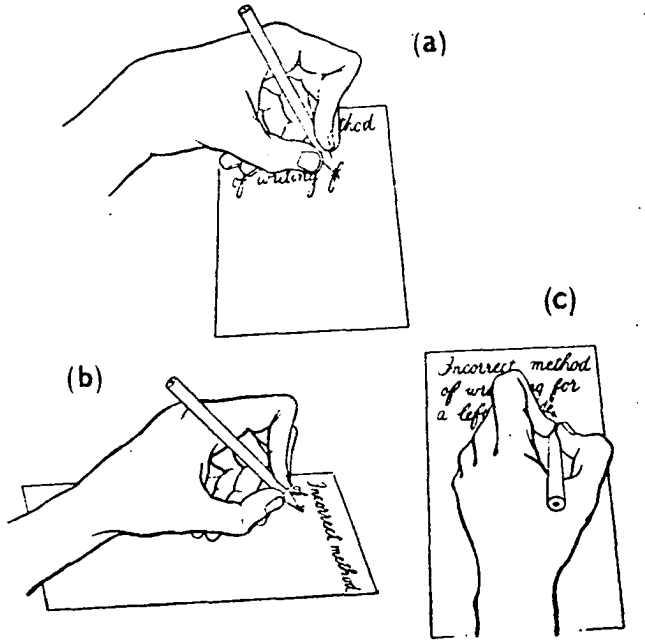
Studies of Body Position and Efficiency

Industry has spearheaded research in body position and worker efficiency in their attempts to increase efficiency and reduce expenses. Results of such efficiency studies have led to many accommodations for the left-handed factory worker.

Industry made the adjustments necessary to insure employee efficiency, because it was directly related to an

Figure 1

ILLUSTRATION OF INCORRECT WRITING POSITIONS ADOPTED BY LEFT-HANDED WRITERS

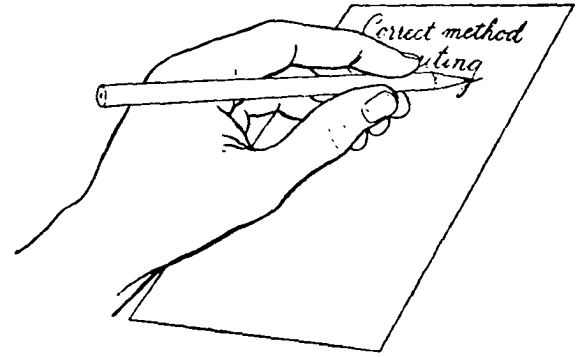


(a) arm hooked above writing
(b) writing in towards body
(c) with arm cramped in to side

(Burns, 1968)

Figure 2

ILLUSTRATION OF CORRECT POSITION FOR WRITING WITH THE LEFT HAND



(Burns, 1968)

economic motive. Educators, however, have been more concerned with students' academic performance than with psychomotor efficiency. Therefore, very little attempt was made to accommodate the left-handed student. This is only one of the many reasons why educators have consistently relegated educational equipment, materials, and supplies to a secondary position. Due to the continued emphasis on individual student rights, however, there has been a renewed interest in the study of left-handedness. Mainly because of its possible relationship with academic achievement.

Blai (1971) investigated the hypothesis that it is mixed-dominance among left handers (left-handed and right-eyed) that is related to academic learning difficulties among such individuals, rather than the generally held notion that their difficulties stem from the fact that they are left handers in a predominantly right-handed world. The experimental subjects were divided into three groups: (1) left-handed, mixed dominance, (2) left-handed, unmixed dominance, and (3) right-handed. All group members were college Freshmen females. At the end of the freshman year, the cumulative grade-point averages (GPA of all three groups were compared. Blai found that the left-handed, mixed dominance group made significantly lower grades than either of the other two groups. He concluded that the crossed-laterality effects of mixed dominance was the reason for lower grade point averages.

In a somewhat related but contradictory study,Kershner (1970) conducted a study in which he compared the effects of laterality, movement, and language on children's ability to conserve multiple space relations. The sample for the experiment consisted of 160 first-grade students (80 boys and 80 girls) who were matched on IQ and socioeconomic status. Subjects were tested for their functional knowledge of language (Piaget's schedule) and lateral dominance and assigned to a "Spectator" or "Participation" condition. A special apparatus was devised and constructed to test the participants' spatial conservation. Kershner found that those children who were right or left-handed had less success in reproducing space relations than did children who were mixed in their laterality. Further analysis of the data showed that right-handed, left-eyed children produced the main laterality effect. These results are somewhat contradictory to those obtained by Blai (1971) in which he concluded that mixed dominance was a definite handicap to college freshmen.

At least two other studies were conducted in which the researchers were unable to find any relationship between academic achievement and handedness and eyedness of students.

Boos and Hillerich (1968) replicated two earlier disparate studies of "controlling eye" and "dominant eye"

on reading achievement. They used 277 seventh and eighth grade students as subjects, and compared their scores on a variety of psychomotor skills to their reading achievement scores taken from the California Achievement Test. The authors concluded that neither eye dominance or eye control was a significant factor in the reading achievement of the subjects studied.

CHAPTER III

METHODS AND PROCEDURES USED IN THE EXPERIMENT

In the present study, experimental procedures were used to determine the debilitating effects on psychomotor performance of one hundred twenty (N=120) adults enrolled in adult education classes at a vocational-technical school. Left-handed (N=40), right-handed (N=40), and crossed-laterality (N=40) groups were determined from their responses to the Left-Handed/Right-Handed Criterion Questionnaire (appendix A) and the Harris Hole-in-Card Test (appendix B). These groups performed speed tasks under two different seating arrangements. Times recorded for their performances were compared to test three null hypotheses.

This Chapter contains an explanation of the methods and procedures used in the experiment. These methods and procedures were classified as follows: (1) Pre-Experimental Procedures, (2) Data Collection Procedures, and (3) Data Analysis Procedures. Each of these areas is discussed at length in this Chapter.

PRE-EXPERIMENTAL PROCEDURES

The pre-experimental procedures are all those tasks which the researcher needed to complete before the

actual collection of the data began. The most important of these tasks are described in the following sections.

Choice of Research Design

The first pre-survey procedure was to choose the proper research design for the conduct of the study. The words "research design" are intended to mean the plan, structure, and strategy of investigation conceived to obtain answers to research questions and to control external sources of variation. The Plan is the overall scheme or program of the evaluation problem; the Structure is the more specific structure or paradigm of the actual manipulation of the independent variables being controlled; and the Strategy as used here is even more specific than the structure--it is the actual methods to be used in the gathering and analysis of the data.

A research design serves two basic purposes: (1) it provides answers to research questions posed by the investigator; and (2) it controls external sources (independent variables) of variation. In other words, it is through the design of a study that research is made effective and interpretable. Kerlinger (1973) makes the following statement in regard to research and evaluation designs:

> . . . How does design accomplish this? Research design set up the framework for 'adequate' tests of the relations among

> variables. The design tells us, in a sense, what observations (measurements) to make, how to make them, and how to analyze the quantitative representations (data) of the observations. Strictly speaking, design does not 'tell' us precisely what to do, but rather suggests the directions of observation-making and analysis, how many observations should be made, and which variables (independent variables) are active variables and which are assigned. We can then act to manipulate (control) the active variables and to dichotomize or trichotomize or otherwise categorize the assigned variables. A design tells us what type of statistical analysis to use. Finally, an adequate (proper for the particular situation) design outlines possible conclusions to be drawn from the statistical analysis (pp. 196-197) (Parentheses material added).

This research design chosen for the present experiment was a multiple-sample true-experimental research design preceded by the random sampling of participants from three (3) finite populations. A paradigm of this research design is presented in figure 3.

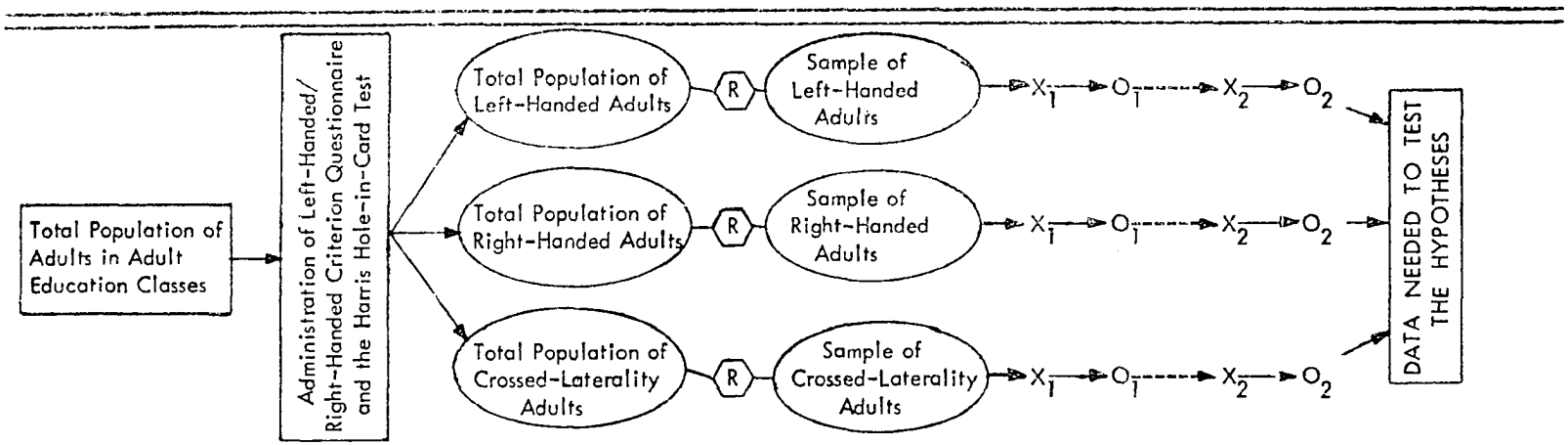
Selection of Adult Participants

The next step of the pre-experimental procedures was the selection of the adult participants. This procedure involved the grouping of all potential participants into populations and the subsequent selection of samples from each of these populations.

The researcher began with the total universe of adults enrolled in adult education classes during the Fall Semester of the 1975-76 school year at Gordon Cooper Area Vocational-Technical School, Shawnee, Ok. The universe was

Figure 3

RESEARCH DESIGN USED IN THE PRESENT STUDY



Explanation of Symbols:

R = Random Selection of Subjects

X_1 = First Experimental Condition

X_2 = Second Experimental Condition

O_1 = First Observation made; Time Needed to Perform First Coding Task Recorded

O_2 = Second Observation made; Time Needed to Perform Second Coding Task Recorded

given the Left-Handed/Right-Handed Criterion Questionnaire (appendix A) and the Harris Hole-in-Card Test (appendix B) to determine their appropriate classification. This procedure resulted in three general populations; (1) population of left-handed adults, (2) population of right-handed adults, and (3) the population of crossed-laterality adults (those adults who were right-handed and left-eyed or left-handed and right-eyed).

At this point there was no accurate method of determining the number of adults in each population. If they were a normally-distributed population, however, the percentages in each group would be approximately eighty percent (80%) right-handed, twelve percent (12%) left-handed, and eight percent (8%) crossed-laterality. These percentages would result in numbers sufficiently large to complete the three samples. Samples would be randomly drawn from each population to serve as the experimental subjects.

Instruments

Two instruments were used in the proposed study. One was used to determine handedness, while the other was used to determine eyedness.

The Test for Determining Handedness

It was necessary for the researcher to develop a questionnaire for determining handedness. The instrument

developed is an adaptation of an instrument used by Koch (1931). Several tasks were listed on the questionnaire along with some biographical information. The preliminary draft was then submitted to a test consultant and the Doctoral Committee for their comments and suggestions. After several revisions, the instrument shown in appendix A, The Left-Handed/Right-Handed Criterion Questionnaire, was finalized as the instrument to be used in determining participants' handedness. The instrument was administered to a small population as part of a pilot study. Pilot study results necessitated a slight change in the directions, but no major changes were made.

The Test for Determining Eyedness

A second instrument was selected for determining the participants' eyedness (eye preference). The instrument chosen for this task was the Harris Hole-in-Card Test of Eye Dominance (Harris, 1947).

The authors report the validity of the Harris Hole-in-Card Test as ranging from .94 to .99 and the reliability as varying from .84 to .89.

Buros (1972) reports the validity of the Harris Hole-in-Card Test as ranging from .88 to .94 and the test-retest reliability as ranging from .80 to .85.

These validity and reliability data are sufficient for measuring the variables indicated.

Choice of Speed Tasks to be Performed by the Experimental Groups

The next step in the pre-experimental procedures was the selection of a speed task which would be performed by all three groups under both seating conditions. The purpose of the speed task was to determine the efficiency of each group without revealing the true nature of the experiment. It is important that the participants not realize the purpose of the experiment, since such knowledge could produce a "Hawthorne Effect" (Orne, 1962).

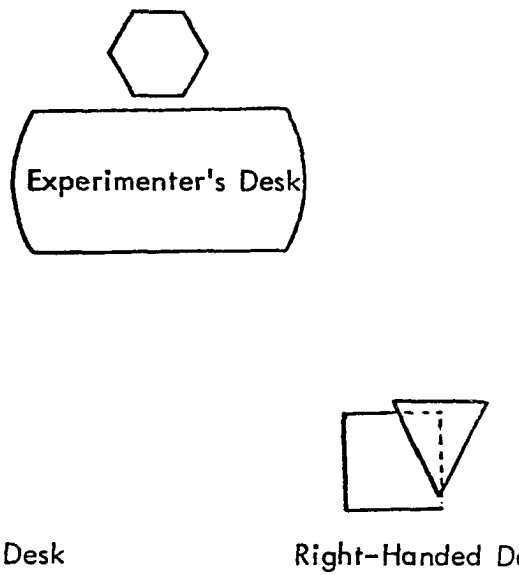
The speed test chosen for the experiment was the coding of the alphabet in reverse order. This is a procedure suggested by Popham (1970) to disguise experimental objectives.

EXPERIMENTAL PROCEDURES

The experimental procedures consisted of collecting the data from the right-handed, left-handed, and crossed-laterality adults participating in the study. These data were collected from the adults on a small group or individual basis. Each adult was brought into the testing facility (See figure 4) and seated at one of the desks. Directions were given concerning the reverse coding of the alphabet starting with the letter "Z" and ending with the letter "A." The number of seconds needed to complete the coding task was recorded and the subject was moved to the alternate desk. The coding task was then

Figure 4

PHYSICAL ARRANGEMENT OF THE TESTING FACILITY



completed the second time, and the time (in seconds) was recorded on the data sheets. These same procedures were followed until all right-handed, left-handed, and crossed-laterality adults had performed the coding task under both the compatible and incompatible conditions. After all data had been collected, the data analysis procedures began.

DATA ANALYSIS PROCEDURES

The third major area of methods and procedures was that of the data analysis procedures. These procedures began as soon as all data had been collected from the three groups of participants.

The first part of the data analysis procedures was the computation of descriptive statistics for each group's data. The descriptive statistics calculated for each set of the data were the mean ($\overline{X}$), standard deviation (S), and variance (S^2). These statistics were used to make further comparisons among the times recorded for each group.

Statistical Analysis

The three hypotheses stated in Chapter I were tested by using a one-way analysis of variance testing statistic in conjunction with a fixed design (Ferguson, 1971). Ferguson indicates that the one-way analysis of variance (ANOVA) yields a single F value. Preliminary comparisons were made among the variances (S^2) of the

groups, since homogeneity of sample variances is one of the underlying assumptions of the ANOVA. In this case, the F-Maximum Test for Homogeneity of Sample Variances (Bruning & Kintz, 1970) was used to make the preliminary comparisons.

In addition to the ANOVA testing statistic, significant F values were followed by further post hoc comparisons among individual group means. In the present study, the Newman-Keuls Test for ranges among means was used to make all post hoc comparisons (Kirk, 1971).

CHAPTER IV

RESULTS OF STATISTICAL ANALYSIS

One-hundred twenty (N=120) adults who were enrolled in vocational-technical education classes were asked to complete a speed test of psychomotor coding. Forty (N=40) right-handed adults, forty (N=40) left-handed adults, and Forty (N=40) crossed-laterality adults acted as subjects in the study. Participants were seated alternately in right- and left-handed desks (arm chairs) to determine the amount of debilitating effect being experienced as a result of having to work from a seating arrangement that was not compatible to their hand orientation. Participants were randomly assigned to the seating arrangements in order to control for practice effects. The amounts of time needed to complete the coding task while seated in each chair were subtracted to determine the debilitating effects caused by the seating arrangement. Difference scores were compared for the right-handed, left-handed, and crossed-laterality adults in order to test three null hypotheses. This chapter contains the results of testing these hypotheses. Ancillary findings are presented in the second part of the chapter, and a summary of all findings is presented at the end of the Chapter.

Descriptive Statistics of the Three Groups' Performances

Before the hypotheses could be tested, it was necessary to compute the descriptive statistics of the three groups' times and compare the sample variances. The means and standard deviations of the time needed to code the alphabet in the right-handed desk, in the left-handed desk, and the difference between the two times are presented in table 1. The raw scores are presented in the appendices.

Comparisons of the Sample Variances

It was necessary to compare the variances of groups' times. The analysis of variance statistic (ANOVA) used in testing the primary hypotheses assumes homogeneity of sample variances (Ferguson, 1972). The F-Maximum Test for Homogeneity of Sample Variances was used to make the comparisons (Bruning & Kintz, 1970). The variances and results of the statistical calculations are presented in table 2.

The results presented in table 2 show that the variances calculated for the three groups' coding times were homogeneous and the assumptions for the ANOVA testing statistic were met. This allowed the calculations to proceed as planned.

TABLE 1

MEANS AND STANDARD DEVIATIONS OF RIGHT-HANDED DESK TIMES, LEFT-HANDED DESK TIMES, AND DIFFERENCE TIMES AS RECORDED FOR THE THREE GROUPS OF ADULTS.

Group		Number of Seconds in Right-Handed Desk	Number of Seconds in Left-Handed Desk	Difference Between Orientations
Right-Handed and Right-Eyed	Means	68.025	77.778	9.250
	Standard Deviations	43.919	48.224	14.251
Left-Handed and Left-Eyed	Means	87.900	85.100	- 2.800
	Standard Deviations	36.932	35.843	14.094
Crossed-Laterality	Means	64.700	65.850	1.150
	Standard Deviations	34.153	34.494	14.012

TABLE 2

RESULTS OF COMPARING THE VARIANCES COMPUTED FOR RIGHT-HANDED CHAIR TIMES, LEFT-HANDED CHAIR TIMES, AND TIME DIFFERENCES

Source of Variation	Right-Handed Group	Left-Handed Group	Crossed-Laterality Group	Homogeneity of Variance Results	
Variances of Right-Handed Desk Times	1,928.88	1,363.97	1,166.43	F = 1.654	df = 2/38: p > .05
Variance of Left-Handed Desk Times	2,325.55	1,284.72	1,189.84	F = 1.955	df = 2/38: p > .05
Variance of Time Differences	203.09	198.64	196.28	F = 1.035	df = 2/38: p > .05

Results of Testing Null Hypothesis Number One

The null proposition of the first hypothesis was tested as follows:

Ho_1 There is no statistically significant difference among the right-handed desk/left-handed desk difference times calculated for the right-handed, left-handed, and crossed-laterality adults.

The first null hypothesis was tested by comparing the difference times calculated for the three groups of adults. A one-way analysis of variance (ANOVA) was used to make the statistical comparisons. The results of the statistical calculations are presented in table 3.

The data presented in table 3 show that there was a significant difference among the difference times calculated for the three groups of adults ($F = 10.605$, $df = 2/119$; $p < .001$). These results allowed the researcher to reject the first null hypothesis.

Additional comparisons were made to locate specific differences among the group means. A Newman-Keuls Test for ranges among sample means was used to make these post hoc comparisons. The results are presented in table 4.

The results presented in table 4 show that the left-handed adults experienced significantly less debilitating effects than either the right-handed or

TABLE 3

A COMPARISON OF THE DIFFERENCE TIMES CALCULATED FOR THE RIGHT-HANDED, LEFT-HANDED, AND CROSSED-LATERALITY ADULTS.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance Level
Between Groups	3,018	2	1,059	10.605	$p < .001$
Within Groups	16,648	117	142.29	---	
TOTAL	19,666	119	---		

TABLE 4

SUMMARY TABLE FOR THE NEWMAN-KEULS TEST AMONG THE DIFFERENCE TIMES COMPUTED FOR THE RIGHT-HANDED, LEFT-HANDED, AND CROSSED-LATERALITY ADULTS.

Rank-Ordered Mean Values		$\overline{X}_2$	$\overline{X}_3$	$\overline{X}_1$
Left-Handed Adults	$\overline{X}_2 = -2.80$	---	3.95*	12.05***
Crossed-Laterality Adults	$\overline{X}_3 = 1.15$		---	8.10**
Right-Handed Adults	$\overline{X}_1 = 9.25$			---

$MS_{Error} = 142.29$

*$p < .05$
**$p < .01$
***$p < .001$

crossed-laterality adults when they completed the coding task in the left-handed desk. In fact, working in the left-handed desk had a facilitating effect for the left-handed adults, whereas the left-handed desk was debilitating to both the right-handed and crossed-laterality groups. The results of table 4 also show that the crossed-laterality group experienced significantly less debilitating effects than the right-handed group.

Results of Testing Null Hypothesis Number Two

The second null hypothesis was tested in order to further explain the results derived from testing the first hypothesis. The null proposition of the second hypothesis was tested as follows:

Ho_2 There is no statistically significant difference among the amounts of time the three groups needed to complete the coding task while seated in the right-handed chair.

The second null hypothesis was tested by comparing the times recorded for the three groups as they completed the coding task while seated in the right-handed chair. A one-way analysis of variance was used to make the comparison among the means of the three groups. Results of the statistical calculations are presented in Table 5.

The results presented in Table 5 show that there was a significant difference among the times recorded for the three groups as they completed the coding task in the right-handed chair ($F = 4.129$, $df=2/119; p < .05$). These

TABLE 5

A COMPARISON OF THE TIMES RECORDED FOR THE THREE GROUPS AS THEY COMPLETED THE CODING TASK IN THE RIGHT-HANDED CHAIR

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance Level
Between Groups	12,591	2	6,295.51	4.129	$p < .05$
Within Groups	178,371	117	1,524.54		
TOTAL	190,962	119			

results allowed the researcher to reject the second null hypothesis.

Additional comparisons were made to locate specific differences among the group means. A Newman-Keuls Test for mean ranges was used to make these post hoc comparisons. The results are presented in Table 6.

A close examination of the average times computed for the three groups while seated in the left-handed chair will give some indication why there was not a significant difference among the groups' average times. The right-handed adults needed much more time to complete the task while seated at the left-handed desk. The crossed-laterality also needed more time while seated at the left-handed desk. However, the left-handed adults needed less time to complete the task while seated at the left-handed desk. Thus, the differences among the average times recorded for the three groups became less when the coding task was performed from the left-handed chair.

Again it should be emphasized that these results were not the result of a practice effect. Participants were randomly assigned to the right- and left-handed chairs as they began their first coding of the alphabet, as a means of controlling any practice effects which might occur.

TABLE 6

SUMMARY TABLE FOR THE NEWMAN-KEULS TEST AMONG THE AVERAGE TIMES RECORDED FOR THE THREE GROUPS' PERFORMANCES FROM THE RIGHT-HANDED CHAIR

Rank-Ordered Mean Values		$\bar{X}_3$	$\bar{X}_1$	$\bar{X}_2$
Crossed-Laterality Adults	$\bar{X}_3 = 64.70$	---	3.33	23.2*
Right-Handed Adults	$\bar{X}_1 = 68.03$		---	19.87*
Left-Handed Adults	$\bar{X}_2 = 87.90$			---

$MS_{Error} = 1,524.54$

*$p < .05$

Results of Testing Null Hypothesis Number Three

A third null hypothesis was tested as a means of further explaining the results derived from testing the first hypothesis. The null proposition of the third hypothesis was tested as follows:

Ho_3 There is no statistically significant difference among the amounts of time the right-handed, left-handed, and crossed-laterality adults needed to complete the coding task while seated in the left-handed chair.

The third null hypothesis was tested by comparing the times recorded for the three groups as they completed the coding task while seated in the left-handed chair. A one-way analysis of variance was used to make the comparison among the means of the three groups. Results of the statistical calculations are presented in Table 7.

The results presented in Table 7 show that there was not a significant difference among the times recorded for the three groups as they completed the coding task in the left-handed chair ($F = 2.301$, $df=2/119$; $p > .05$). These results would not allow the researcher to reject the third null hypothesis.

Ancillary Findings

Several secondary findings were made during the course of the experiment. Most of these findings came from participants' responses to the Left-Handed/Right-Handed Criterion Questionnaire. Information concerning

TABLE 7

A COMPARISON OF THE TIMES NEEDED BY THE RIGHT-HANDED, LEFT-HANDED, AND CROSSED-LATERALITY ADULTS TO COMPLETE THE CODING WHILE SEATED IN THE LEFT-HANDED CHAIR

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-Value	Significance Level
Between Groups	7,552.4	2	3,776.2	2.301	$p > .05$
Within Groups	192,003.6	117	1,641.06		
TOTAL	199,556	119			

the three groups' ages, sex, and schooling is presented in table 8. These data show that all three groups were quite similar along these three variables.

Information concerning the number of years the participants had attended school was solicited, because their experience with arm chairs could be closely related to their performance on the coding task. While this was the case, the amount of schooling reported by the three groups was statistically equal, and the effects of experience were equalized for all groups.

The Incidence of Left-Handedness Within the Immediate Family

One of the most interesting aspects of the study involved the incidence of left-handedness among the immediate family members of left-handed participants. Results reported on the Left-Handed/Right-Handed Criterion Questionnaire showed that there was a much higher incidence of left-handedness among relatives of left-handed adults than among right-handed adults. Results of the questionnaire responses are presented in table 9.

The data presented in table 9 show that there was a much higher incidence of left-handedness among grandparents, parents, siblings, and children of left-handed adults than among these same relatives of right-handed and crossed-laterality adults. The greatest discrepancy

TABLE 8

BIOGRAPHICAL INFORMATION SUPPLIED BY
ALL POTENTIAL PARTICIPANTS

Group	Average Age	Sex		Years of Schooling
		% Male	% Female	
Right-Handed and Right-Eyed	34.30 yrs.	42%	58%	12.96 yrs.
Left-Handed and Left-Eyed	31.82 yrs.	69%	31%	10.81 yrs.
Crossed-Laterality	30.58 yrs.	56%	44%	14.20 yrs.
TOTALS	31.60 yrs.	47%	53%	12.29 yrs.

TABLE 9

INCIDENCE OF LEFT-HANDED RELATIVES AS REPORTED BY THE LEFT-HANDED, RIGHT-HANDED, AND CROSSED-LATERALITY ADULTS

Group	Grand Parents		Parents		Other Siblings		Children		None
	#	%	#	%	#	%	#	%	
Right-Handed and Right-Eyed (N = 75)	1	1.35	5	7.76	6	8.11	5	6.76	77%
Left-Handed and Left-Eyed (N = 46)	8	17.78	15	33.33	13	28.89	6	13.33	35%
Crossed-Laterality (N = 43)	1	2.44	10	24.39	8	19.51	4	9.76	54%

was noted among the incidence of left-handed parents reported by the three groups. Less than seven percent of the right-handed adults and less than twenty-five percent of the crossed-laterality adults reported having left-handed parents. On the other hand, more than one-third of the left-handed adults reported one or both of their parents was left-handed. Left-handed adults also reported a much higher incidence of left-handedness among their grandparents, brothers and sisters (siblings), and children than was reported by the right-handed and crossed-laterality adults. These results imply that left-handedness is an inherited trait. This has also been reported by previous researchers. However, this does not answer the question of the origin of left-handedness. It simply presents a plausible explanation of how left-handedness is passed on from one generation to the next. An equally plausible explanation is that left-handedness is a learned characteristic. Left-handed parents would naturally demonstrate simple acts for their children in a left-handed way. The children, in turn, may develop a left-handed preference simply because of the parents' examples and their desire to please the parent. This is a question which is beyond the scope and nature of the present study.

Summary of Results

Three hypotheses were tested at the .05 level of confidence to determine the amount of debilitating effects being experienced by the right-handed, left-handed, and crossed-laterality adults as they completed psychomotor coding tasks in both right- and left-handed arm chairs.

Results of testing the first null hypothesis showed that the left-handed adults experienced significantly less debilitating effects than the right-handed and crossed-laterality adults as a result of having to complete the coding task while seated in a left-handed chair. Crossed-laterality adults also experienced significantly less debilitation effects than the right-handed adults.

Results of testing the second null hypothesis showed that the left-handed adults needed significantly more time to complete the coding task while seated in the right-handed chair than was needed by the right-handed and crossed-laterality adults to complete the coding task under the same conditions.

Results of testing the third null hypothesis showed that there is no significant difference among the times needed by the three groups to complete the coding task while seated in the left-handed chair.

Ancillary findings showed that the three groups had similar amounts of educational training and were very

comparable in age. The left-handed adults reported a much higher incidence of left-handedness among grandparents, parents, siblings (brothers and sisters), and children than was reported by right-handed and crossed-laterality adults. This led to the general conclusion that handedness is an inherited characteristic.

The conclusions drawn from these results are presented in chapter V. The final chapter also contains a short summary of the entire study and implications for further research in the area of left-handedness.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER RESEARCH

The problem in this study was to determine the debilitating effects of having right-handed, left-handed, and crossed-laterality adults complete psychomotor coding tasks while seated in arm chairs (desks) which were not compatible with their handedness orientation. One-hundred twenty (N=120) adults who were enrolled in vocational-technical education classes were asked to reverse code the alphabet while seated alternately in right- and left-handed arm chairs. Forty (N=40) right-handed, and forty (N=40) left-handed, and forty (N=40) crossed-laterality adults were randomly assigned to the different chair positions to control for practice effects. The times (in seconds) needed to complete the coding task while seated in both the right-handed and left-handed arm chairs were recorded, while the difference between the two times was regarded as the amount of debilitating effect being experienced. Left-handed desk, right-handed desk, and difference times were used to test three null hypotheses. Additional information was solicited from participants by having them complete a Left-Handed/Right-Handed Criterion Questionnaire.

Results of the Experiment

Results of testing the first null hypothesis showed that the left-handed adults experienced significantly less debilitating effects than the right-handed and crossed-laterality adults as a result of having to complete the coding task while seated in a left-handed chair. Crossed-laterality adults also experience significantly less debilitation effects than the right-handed adults.

Results of testing the second null hypothesis showed that the left-handed adults needed significantly more time to complete the coding task while seated in the right-handed chair than was needed by the right-handed and crossed-laterality adults to complete the coding task under the same conditions.

Results of testing the third null hypothesis showed that there is no significant difference among the times needed by the three groups to complete the coding task while seated in the left-handed chair.

Ancillary findings showed that the three groups had similar amounts of educational training and were comparable in age. The left-handed adults reported a much higher incidence of left-handedness among grandparents, parents, siblings (brothers and sisters), and children than was reported by right-handed and crossed-laterality adults.

Conclusions Drawn from the Results of the Experiment

Several conclusions were drawn from the results obtained during the experiment. These conclusions are presented as an extension of the study and should not be generalized to other groups and/or situations unless the contexts of the situations are quite similar. The overall conclusions were as follows:

CONCLUSION NUMBER 1

Results of testing the first null hypothesis led to the conclusion that the left-handed adults experienced much less difficulty than the right-handed and crossed-laterality adults when completing the coding task while seated in the left-handed chair. There are two possible explanations for these results. First, the left-handed adults had had some experience with both left-handed and right-handed desks, whereas the right-handed and crossed-laterality adults had not had to adjust to a left-handed desk and experienced some difficulty when it became necessary to do so. This previous experience is one possible explanation for the differences among the amounts of debilitating effects experienced by the three groups.

A second possible explanation is in the actual coding times recorded for the three groups' performances. The left-handed adults needed much more time to complete the coding task than either the right-handed or crossed-laterality group. Because the left-handed adults worked at

a slower pace, it was anticipated that the time needed to complete the coding task under the two seating arrangements would be fairly compatible. On the other hand, the faster coding rates of the right-handed and crossed-laterality adults was difficult for them to maintain when they were seated in the left-handed arm chairs which were incompatible with their handedness orientation.

CONCLUSION NUMBER 2

Results of testing the second null hypothesis led to the conclusion that the right-handed and crossed-laterality adults needed much less time than the left-handed adults to complete the reverse coding of the alphabet. There are two possible explanations for the differences among the times recorded for the three groups. First, it has been established through previous research that left-handed individuals have been consistently slower in their writing habits than right-handed or crossed-laterality individuals (Enstrom, 1962; Guilford, 1926). Second, physical strain of having to work from a desk which was not compatible with their handedness orientation no doubt caused some loss of efficiency. It was concluded that the greater time needed by the left-handed adults was a result of these two factors.

CONCLUSION NUMBER 3

Results of testing the third null hypothesis led

to the conclusion that there is no real difference among the amounts of time the left-handed, right-handed, and crossed-laterality adults needed to complete the coding task while seated in the left-handed arm chairs. While the right-handed and crossed-laterality adults showed lower times than the left-handed adults, differences were not as great as when they completed the task while seated in the right-handed chairs. The most plausible explanation for this conclusion is that the left-handed adults found the left-handed arm chair facilitating to their coding performance, while the right-handed and crossed-laterality adults experienced debilitating effects from having to reverse code the alphabet from the left-handed chairs.

CONCLUSION NUMBER 4

Information gleaned from the Left-Handed/Right-Handed Criterion Questionnaire led to the conclusion that there is a definite relationship between left-handedness and family relationships. The left-handed adults reported a much higher incidence of left-handedness among grandparents, parents, other siblings (brothers and sisters), and children than was reported by right-handed or crossed-laterality adults. Previous studies have indicated that left-handedness is an inheritable trait (Hildreth, 1960; Guilford, 1926), and the present experiment lends credence to this premise.

Implications for Further Research

During the course of this experiment several ideas and ancillary studies were formulated. Many of these studies could be easily designed and shown under significant contribution to education in general.

Although the essence of this research design dealt with a time speed of task operation by left-dominant, crossed-laterality, and right-handed adults, to determine the debilating effects of certain classroom paraphernalia, the true dilemma of the left-dominant individual cannot be fully examined in this study. Personal interviews with left-dominant individuals during the testing exercise of this study pointed out the problems of a right-dominant world.

There is little question in this experimenter's mind that the self-concept of the left-dominant individual undergoes a tremendous shock at an early age. During the first few years of formal education the left-dominant individual is at a tremendous disadvantage. During this pre-operational stage, classified by Piaget as the initial thought stage (Piaget, 1954), the child is operating on a concrete level. Learning basic concepts such as reading and writing from a right-handed model (teacher) with techniques designed primarly for right-handers only adds to the left-dominant individual's dilemma.

Conducting a research project which deals specifically with the self-concept development of left-dominant individuals may help to provide insight into the question of how detrimental it is to the self-concept to be left-handed and left-eyed in a right-handed world. This aspect of the left-dominant question needs additional exploration and research.

Reflection of the present research design to students in grades 3-6-9-12 could provide indices which would allow for greater generalizability. The present study is limited to an adult population. Research concerning the instruction of left-dominant individuals may provide answers to questions dealing with teachers' success in meeting the total needs of the individual i.e. especially left-dominant individuals.

Another possible research study dealing with left-dominant individuals would be to explore stress factors associated with left-dominant individuals performing psychomotor endurance tasks. Research indicates (Burns, 1968) that the left-dominant individual, because of his unnatural style of writing, becomes fatigued quicker than his right-handed counterpart.

Various types of bio-feedback apparatus could be used to measure these stress factors. This seems to be a paramount problem of left-dominant individuals. Long periods of writing (taking lectures notes in a class)

prove to be a handicap to the left-dominant individual who constantly loses not only visual contact with the speaker as he trys to write, but also support for his writing arm since he has his note pad in his lap a great portion of the time. The present study, because of the short amount of time necessary to complete the task was not designed to measure physiological stress factors.

The problems encountered by left-handed athletes would also be a fruitful area of research. The researcher, a former basketball coach, has noted that the nature of the game of basketball provides numerous opportunities calling for the use of both the left and right hands. However, it is easy to detect certain idiosyncrasies associated with left-dominant individuals. For example, the left-dominant player seems to be much more "left-oriented" than "right-handed" players are right-oriented. In an attempt to explore this question in more detail, several coaches were asked their observations about coaching left-handed athletes. (See Appendix F)

The coaches selected for comments in this section were not selected randomly. Selections were made by personal contacts and acquaintances and does not proport to be a scientific procedure.

The coaches comments are included in this study in order to point out some implications for further

research. An analysis of the comments made by the coaches reveals a common characteristics of left-handers noticed by many of the coaches. They noted the fact that left-handers seemed to be more left-oriented than right-handed players were right-oriented. This would make an interesting research project. A study could be designed which required participants to perform psychomotor tasks with their dominant hand and then to learn and perform the same task with their recessive hand. The results of such a research project could have meaningful education implications for the teaching of left-dominant individuals.

Another observation made by most coaches who were interviewed was that, contrary to a popular belief (Hildreth, 1960), left-handers do not learn more slowly than right-handers. The left-hander didn't seem to experience significantly more problems in learning various offenses than his right-handed counterpart.

The comments made by many of the coaches and athletic directors seem to suggest that left-handed athletes are more "homogenous" to their handedness than right-handed athletes. This could be investigated through organized sports where physiological measures could be recorded.

It would appear at this time that left-handedness must be investigated more from the physiological/biological standpoint than from a psychological/sociological dimension.

Much research is still needed to answer the many questions raised by this study. It is anticipated that further investigations into the idiosyncrasies of the left-dominant individual will yield information that can help to solve the riddle of left-handedness. Organized sports may be able to conduct the most valid and reliable research in this area, since they are able to make exact physiological measures.

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APPENDIX A

QUESTIONNAIRE USED IN DETERMINING THE LATERALITY ORIENTATION (HANDEDNESS) OF THE ADULT PARTICIPANTS

LEFT-HANDED/RIGHT-HANDED CRITERION QUESTIONNAIRE

Name:_____ Age:_____

Sex: M F Date:_____

1.	Are there any left-handed members in your immediate family?	Yes	No
2.	If so, what is their relationship to you (father, mother, etc.)	_____	_____
3.	Do you consider yourself to be right-handed or left-handed?		_____
4.	Have you ever had an accident which caused you to have to learn to use your other hand?	Yes	No
5.	How many years did you attend school?		_____
6.	When you attended school, did you use arm chairs as desks?	Yes	No
7.	If you used arm chairs, were they right-handed or left-handed?		_____
8.	Did you have trouble writing because you were left-handed and the arm chair was right-handed or you were right-handed and the arm chair was left-handed?	Yes	No

Directions: Please indicate your hand preference after each of the statements listed below. Circle one of the letters after each question.

R = Right Hand
L = Left Hand
E = Either Hand or No Preference

1.	With which hand do you hold a pen or pencil when you write?	R	L	E
2.	With which hand do you hold a spoon when you eat?	R	L	E
3.	With which hand do you hold a paring knife?	R	L	E
4.	With which hand do you dial a phone?	R	L	E
5.	With which hand do you brush your teeth?	R	L	E
6.	With which hand do you hold a glass when you drink?	R	L	E
7.	With which hand do you hold scissors when cutting paper?	R	L	E
8.	With which hand do you turn a faucet?	R	L	E
9.	With which hand do you hold a comb when combing your hair?	R	L	E
10.	Which of your hands do you believe is stronger?	R	L	E

APPENDIX B

THE HARRIS HOLE-IN-CARD TEST USED IN DETERMINING THE DOMINANT EYE OF THE ADULT PARTICIPANTS

HARRIS HOLE-IN-CARD TEST OF EYE DOMINANCE/PREFERENCE

Directions: Hold the card 12-14 inches away from your face. Make sure both eyes are open. Look through the hole in the center of the card and focus on a predetermined object or mark. Now close your left eye. Can you still see the mark? If you can, you are right eyed. If you cannot, you are left eyed. Now open your left eye and close your right eye. Can you still see the mark? If you can, you are left eyed. If you cannot, you are right eyed.

APPENDIX C

CORRESPONDENCE REQUESTING PERMISSION TO TEST THE ADULTS WHO PARTICIPATED IN THE EXPERIMENT

November 1, 1975

Mr. Paul Milburn
Adult Education Coordinator
Gordon Cooper Area Vo-Tech
Shawnee, OK 74801

Dear Mr. Milburn:

This correspondence is directed to our telephone conversation a few weeks ago concerning the possibility of your allowing me the opportunity to perform a testing exercise on some of the adults in the Gordon Cooper Evening Program to discern various degrees of laterality and speed of task functioning.

It is hoped that the results of this research study will help to provide additional insights into the teaching of left-laterally dominant individuals.

Your consideration in helping to assimilate this data is greatly appreciated. The results of this study will be made available to the Gordon Cooper Area Vo-Tech upon request.

Sincerely yours,

Earl Garrison

Earl Garrison
Administrative Officer of Curriculum
State Department of Education

EG:rt

PHONE (405) 273-7493 DRAWER 846

Gordon Cooper Area Vocational-Technical School
HIGHWAY 18 AND INTERSTATE 40
SHAWNEE, OKLAHOMA 74801

November 17, 1975

Mr. Earl Garrison
Administrative Officer of Curriculum
State Department of Education
Oklahoma City, Oklahoma

Dear Mr. Garrison:

This letter is in reply to your correspondence of November 1, 1975 and our telephone conversations concerning your testing some of the adults in the Gordon Cooper Vo-Tech School evening classes. We will be most interested in learning of the results of your research pertaining to the left-laterally dominant individuals.

It is believed that your findings will not only be interesting but very helpful to industry and other employers who may employ left-handed individuals. No doubt the employer who understands this type of employee problem can, in many cases, find ways to help the individual be more productive and remove much of the frustration for the individual.

Sincerely,

Paul M. Milburn

Paul M. Milburn
Coordinator, Adult Education

PMM:cs

APPENDIX D

RAW DATA CONCERNING THE RIGHT-HANDED CODING TIMES, LEFT-HANDED CODING TIMES, AND DIFFERENCE TIMES RECORDED FOR THE THREE GROUPS OF PARTICIPANTS

TIME* NEEDED BY THE RIGHT-HANDED AND RIGHT-EYED ADULTS TO COMPLETE THE CODING EXERCISE

Subject Number	Handedness	Eyedness	SECONDS NEEDED TO COMPLETE CODING TASK		
			Right-Handed Desk	Left-Handed Desk	Difference
1.	R	R	180	183	+ 3
2.	R	R	69	97	+28
3.	R	R	90	166	+76
4.	R	R	43	38	- 5
5.	R	R	68	69	+ 1
6.	R	R	61	63	+ 2
7.	R	R	39	43	+ 4
8.	R	R	53	75	+22
9.	R	R	75	89	+14
10.	R	R	42	43	+ 1
11.	R	R	73	76	+ 3
12.	R	R	53	64	+ 9
13.	R	R	53	52	- 1
14.	R	R	253	270	+17
15.	R	R	67	73	+ 6
16.	R	R	62	52	-10
17.	R	R	59	89	+30
18.	R	R	126	129	+ 3
19.	R	R	44	49	+ 5
20.	R	R	31	36	+ 5
21.	R	R	48	56	+ 8
22.	R	R	67	63	- 4
23.	R	R	61	63	+ 4
24.	R	R	55	58	+ 3
25.	R	R	45	51	+ 6
26.	R	R	86	99	+13
27.	R	R	177	186	+ 9
28.	R	R	73	77	+ 4
29.	R	R	44	62	+18
30.	R	R	37	39	+ 2
31.	R	R	88	120	+32
32.	R	R	38	36	- 2
33.	R	R	35	34	- 1
34.	R	R	39	39	00
35.	R	R	35	38	+ 3
36.	R	R	69	73	+ 4
37.	R	R	61	69	+ 8
38.	R	R	43	52	+ 9
39.	R	R	40	80	+20
40.	R	R	39	60	+21
Mean =			68.025	77.778	9.250
Standard Deviation =			43.919	48.224	14.251

* In Seconds

TIME* NEEDED BY THE LEFT-HANDED AND LEFT-EYED ADULTS TO COMPLETE THE CODING EXERCISE

Subject Number	Handedness	Eyedness	SECONDS NEEDED TO COMPLETE CODING TASK		
			Right-Handed Desk	Left-Handed Desk	Difference
1.	L	L	113	105	- 8
2.	L	L	49	47	- 2
3.	L	L	48	46	- 2
4.	L	L	107	101	- 6
5.	L	L	163	161	- 2
6.	L	L	32	28	- 4
7.	L	L	149	141	- 8
8.	L	L	61	65	+ 4
9.	L	L	47	43	- 4
10.	L	L	63	61	- 2
11.	L	L	78	74	- 4
12.	L	L	51	47	- 4
13.	L	L	61	59	- 2
14.	L	L	87	86	- 1
15.	L	L	106	103	- 3
16.	L	L	42	37	- 5
17.	L	L	39	37	- 2
18.	L	L	132	128	- 4
19.	L	L	66	61	- 5
20.	L	L	41	34	- 7
21.	L	L	123	126	+ 3
22.	L	L	93	90	- 3
23.	L	L	107	102	- 5
24.	L	L	171	168	- 3
25.	L	L	61	67	+ 6
26.	L	L	73	71	- 2
27.	L	L	128	124	- 4
28.	L	L	104	102	- 2
29.	L	L	133	121	-12
30.	L	L	110	108	- 2
31.	L	L	97	93	- 4
32.	L	L	63	60	- 3
33.	L	L	83	81	- 2
34.	L	L	107	115	+ 8
35.	L	L	39	43	+ 4
36.	L	L	96	91	- 5
37.	L	L	37	43	+ 6
38.	L	L	128	120	- 8
39.	L	L	101	97	- 4
40.	L	L	127	118	- 9
Mean =			87.900	85.100	- 2.800
Standard Deviation =			36.932	35.843	4.094

* In Seconds

TIME* NEEDED BY CROSSED-LATERALITY ADULTS TO COMPLETE THE CODING EXERCISE

Subject Number	Handedness	Eyedness	SECONDS NEEDED TO COMPLETE CODING TASK		
			Right-Handed Desk	Left-Handed Desk	Difference
1.	L	R	197	189	- 8
2.	R	L	39	40	+ 1
3.	L	R	48	49	+ 1
4.	R	L	107	105	- 2
5.	R	L	84	89	+ 5
6.	R	L	73	78	+ 5
7.	L	R	62	60	- 2
8.	R	L	38	39	+ 1
9.	L	R	55	54	- 1
10.	R	L	110	74	-36
11.	L	R	66	74	+ 8
12.	L	R	28	27	- 1
13.	R	L	68	109	+41
14.	L	R	39	33	- 6
15.	R	L	87	117	+30
16.	R	L	23	31	+ 8
17.	L	R	20	19	- 1
18.	L	R	68	57	-11
19.	R	L	45	51	+ 6
20.	R	L	57	58	+ 1
21.	R	L	49	36	-13
22.	R	L	47	49	+ 2
23.	R	L	68	60	- 8
24.	L	R	40	37	- 3
25.	L	R	39	33	- 6
26.	L	R	63	60	- 3
27.	R	L	48	49	+ 1
28.	R	L	39	43	+ 4
29.	R	L	73	70	- 3
30.	R	L	107	129	+22
31.	L	R	60	45	-15
32.	R	L	63	66	+ 3
33.	R	L	47	34	-13
34.	R	L	75	83	+ 8
35.	R	L	45	47	+ 2
36.	R	L	48	69	+21
37.	R	L	107	127	+20
38.	R	L	154	125	-29
39.	R	L	35	59	+24
40.	L	R	67	60	- 7
Mean =			64.70	65.85	1.15
Standard Deviation =			34.153	34.494	14.012

* In Seconds

APPENDIX E

SUMMARY OF BIOGRAPHICAL AND FAMILY REPORTED BY THE RIGHT-HANDED, LEFT-HANDED, AND CROSSED-LATERALITY ADULTS

RIGHT-HANDED AND RIGHT-EYED

Subj. No.	Sex	Age	Other Left-Handed Sex In Family?	Changed of Handedness	Yrs. of Schooling	Use Arm Chairs?	R or L	Having Trouble Using Chairs?
1.	M	62	No	No	19	Yes	R	No
2.	M	56	No	No	12	Yes	R	
3.	M	35	No	No	17	Yes	R	No
4.	M	38	No	No	19	Yes	R	Yes
5.	F	49	No	No	12	No		
6.	F	38	Brother	No	13	Yes	R	No
7.	F	33	No	No	12	Yes	R	No
8.	F	34	Father	No	13	Yes	R	No
9.	F	21	No	No	12	Yes	R	No
10.	F	23	No	No	16	Yes	R	No
11.	F	20	No	No	15	Yes	R	Yes
12.	F	21	No	No	12	Yes	R	No
13.	F	26	No	No	12	Yes	R	No
14.	F	36	No	Yes	16	Yes	R	No
15.	F	65	No	No	12	Yes	B	No
16.	F	41	No	No	12	No		
17.	F	42	Father, Son	No	12	Yes	B	Yes
18.	F	53	Father	No	15	Yes	R	
19.	M		No	Yes	18	Yes	R	No
20.	M	38	2 Brothers	No	11	Yes	R	No
21.	M	43	No	No	16	Yes	R	No
22.	M	25	No	No	12	Yes	R	No
23.	M	23	No	No	14	Yes	R	Yes
24.	F	33	No	No	12	No		

25.	F	25	No	No	12	Yes	R	No
26.	F	18	No	Yes	12	Yes	R	No
27.	F		Son	No	9	Yes	R	No
28.	M	28	No	No	12	Yes	R	No
29.	M	46	No	No	12	Yes	R	
30.	F	41	No	No	12	Yes	R	No
31.	M	29	No	No	12	Yes	R	
32.	M	42	No	No	14	Yes	R	No
33.	M	47	No	No	12	Yes		No
34.	M	26	No	No	17	Yes	R	No
35.	M	40	No	No		Yes	R	No
36.	M	52	Son	Yes	14	No		
37.	F	36	No	No	10	Yes		
38.	F	46	No	No	12	No		
39.	F	27	No	No	13	Yes	R	No
40.	F	55	No	No	12	No		
41.	F	49	Son	No	13	Yes	R	No
42.	F	47	2 Sons	No	10	No		
43.	M	36	No	Yes	12	No		
44.	F	25	No	No	13	Yes	R	No
45.	F		No	No	9	Yes	R	No
46.	F	38	Daughter	Yes	12	No		
47.	F	40	No	No	12	Yes	R	No
48.	F	19	No	No	15	Yes	R	No
49.	F	18	Father	No	12	Yes	R	No
50.	F			No	12	Yes	R	No
51.	F	37	Grandmother	No	12	No		

52.	F	31	No	No	12	Yes	R	Yes
53.	F	35	Son	No	12	Yes	R	No
54.	F	19	No	No	12	Yes	R	No
55.	F	32	No	No	12	Yes	R	No
56.	F	19	Brother, Sister	No	12	Yes	R	No
57.	M	48	No	No	13	No		
58.	M	33	Mother	No	14	Yes	R	No
59.	F	34	No	No	16	Yes	R	No
60.	M	29	Brother	No	16	Yes	R	No
61.	F	28	No	No	13	Yes	R	No
62.	F	22	No	No	13	Yes	R	No
63.	M	32	No	No	17	No		
64.	M	32	No	No	11	Yes	B	No
65.	F	33	No	No	13	Yes	R	No
66.	M	21	No	No	15	Yes	R	No
67.	M	41	No	No	8	No		
68.	M	30	No	Yes	14	Yes	R	No
69.	M	39	No	Yes	12	No		
70.	F	20	No	No	13	Yes	B	No
71.	M	36	No	No	12	No		
72.	M	20	No	Yes	12	Yes	R	No
73.	M	36	No	No		Yes	R	No
74.	M	39	No	No	10	No		

LEFT-HANDED AND LEFT-EYED

Subj. No.	Sex	Age	Other Left-Handed Sex in Family?	Changed of Handedness	Yrs. of Schooling	Use Arm Chairs?	R or L	Having Trouble Using Chairs?
1.	F	25	Niece, Cousin	No	9	No		
2.	F	22	Mother	No	6	Yes	L	Yes
3.	M	27	Brother	No	11	Yes	R	Yes
4.	M	28	Son, Brother	No	16	Yes	R	No
5.	F	25	No	No	10	No		
6.	F	36	No	No	18	Yes	R	Yes
7.	M	26	Brother	No	6	No		
8.	F	23	Mother	No	8	Yes	R	Yes
9.	M	29	No	No	8	No		
10.	F	31	No	No	6	No		
11.	F	32	No	No	6	No		
12.	F	18	Yes	No		No		
13.	M	26	No	No		No		
14.	M	32	Brother	No	8	Yes	L	No
15.	M	27	No	No	7	No		
16.	M	45	No	Yes	7	Yes	R	Yes
17.	M	51	Father	Yes	8	No		
18.	F	41	No	No	10	No		
19.	M	17	No	No	12	Yes	R	No
20.	F	43	Mother, Brother	No	9	No		
21.	M	44	Father, Mother	Yes	9	Yes	R	No
22.	F	43	Mother	No	9	No		
23.	M	46	No	No	11	No		
24.	M	45	No	Yes	10	No		

LEFT-HANDED AND LEFT-EYED CONT'D.

25.	M	35	Mother, Sister	No	10	Yes	R	No
26.	M	26	No	No	10	Yes	R	Yes
27.	M	26	No	No	10	No		
28.	M	43	No	No	8	No		
29.	M	26	Brother	No	8	No		
30.	M	43	No	No	8	Yes	R	Yes
31.	M	21	Father	No	13	Yes	R	Yes
32.	M	36	Mother	No	16	No		
33.	M	36	Son	No	18	Yes	R	Yes
34.	M	36	Brother	Yes	17	Yes	R	Yes
35.	M	24	Brother	No	14	Yes	R	Yes
36.	M	25	Sister	No	12	No		
37.	M	26	Mother	Yes	13	Yes	R	Yes
38.	F	55	Father, 2 Sons	No	12	Yes	R	Yes
39.	M	25	Brother	No	16	No		
40.	F	34	Mother, Son	No	14	Yes	R	No
41.	M	22	No	No	14	Yes	R	Yes
42.	M	28	Brother	No	16	Yes	R	Yes
43.	M	40	Father	No	12	No		
44.	F	20	Brother	No	14	Yes	R	Yes
45.	M	23	Father	Yes	14	Yes	B	Yes

CROSSED-LATERALITY

Subj. No.	Sex	Age	Other Left-Handed Sex in Family?	Change of Handedness	Yrs. of Schooling	Use Arm Chairs?	R or L Handed	Having Trouble Using Chairs?
1.	M	27	Father	No	12	Yes	R	Yes
2.	M		No	No		No		NO
3.	M	35	No	Yes	19	Yes	R	
4.	M	26	Father	No	10	No		
5.	F	43	Mother	No	12	Yes	R	No
6.	M	35	No	Yes	17	Yes	R	Yes
7.	M	28	Father	No	12	Yes	R	No
8.	M	63	Father	No	16	Yes	R	Yes
9.	M	22	No	No	12	Yes	R	No
10.	M	34	Sister	No	12	Yes	R	No
11.	F	19	No	No	13	Yes	R	No
12.	F	21	No	No	13	Yes	R	No
13.	F	32	No	No	12	Yes	R	No
14.	F	18	No	No	12	Yes	B	No
15.	F	22	No	No	12	Yes	B	No
16.	F	24	Brother	No	15	Yes	R	No
17.	F	23	Brother	No	13	Yes	B	No
18.	F	58	Daughter	No	12	No		
19.	M	35	Son	No	15	Yes	R	Yes
20.	M	28	No	Yes	15	No		
21.	M	35	Brother	No	14	Yes	R	No
22.	F	20	Mother	No	13	Yes	R	Yes
23.	F	48	Mother	No	13	Yes	R	No
24.	F	27	Mother	No	12	Yes	R	No
25.	M	34	Mother	No	16	Yes	R	Yes

CROSSED-LATERALITY CONT'D.

26.	M		Father	No	22	Yes	B	No
27.	F	32	No	No	17	Yes	R	No
28.	F	43	2 Daughters	No	12	Yes	R	No
29.	F	26	No	Yes	15	Yes	R	No
30.	M	17	No	No	12	No		
31.	M	32	No	No	27	Yes	R	Yes
32.	M	29	Son	No	20	Yes	R	Yes
33.	M	30	Brother, Sister	No	24	Yes	R	Yes
34.	F	31	No	No	21	Yes	R	Yes
35.	M	18	No	No	12	No		
36.	F	52	No	No	12	No		
37.	M	45	Yes	Yes	9	Yes	R	No
38.	M	24	Brother, Sister	No	13	Yes	R	No
39.	M	39	No	No	10	Yes	B	No
40.	F	36	Father	No	12	Yes	R	No
41.	M	39	Children	No	8	Yes	L	No

APPENDIX F

NARRATIVE REPORT OF COACHES REMARKS CONCERNING LEFT-DOMINANT ATHLETES

Don Sumner, head basketball coach at Saint Gregory Junior College in Shawnee, Oklahoma, commented on the difficulties of coaching left-handed players by making the following remarks.

> ". . . most of the left-handed basketball players I've coached seemed to be better shooters (than the right-handed players). I've never had any difficulty with the left-handers learning the various offenses, although it appears they prefer to drive to the left much more than the right-handed player prefers to drive to his right . . . I have found that left-handed players are difficult for a right-handed coach to instruct . . . it's difficult for a right-handed coach to demonstrate a left-hander's swing. I have observed that left-handed bowlers have a distinct advantage over right-handed bowlers, because the alley is usually not worn as much on the left side as the right side and as a result the ball will roll with a great deal more accuracy."

Jerry Carlton, head basketball coach at Oscar Rose Junior College in Midwest City, Oklahoma, made the following comments about the various types of basketball offenses.

> ". . . left-handed basketball players have a very difficult time adjusting to and learning a continuity type of offense . . . it seems that our offense usually 'bogs' down when the ball ends up at the left-handed player. I really can't explain this except to say that maybe most offenses are designed for right-handed players . . ."

Dr. Jack Dobbins, head basketball coach at Northeastern Oklahoma State University in Tahlequah, Oklahoma, failed to note any differences between right- and

left-handed players. He states:

> ". . . I haven't noticed any significant differences in coaching left-handed players as opposed to right-handed players . . ."

Gary White, former head basketball coach at Mustang High School in Mustang, Oklahoma, also noted the homogeneous orientation of left-handed basketball players in the following comments;

> ". . . most left-handed basketball players I've coached have had a very difficult time learning to move toward the right . . . they seem to have greater difficulty driving to the right than a right-handed player has driving to the left . . ."

Dave Bliss, head basketball coach at Oklahoma University in Norman, Oklahoma, made a similar observation about left-handed basketball players. He states;

> ". . . left-handed basketball players seem to me to be much more 'left-oriented' than right-handed players are 'right-oriented' . . . we don't try to change left-handed players . . . we are concerned finally if they can get the job done . . . the ball in the basket . . ."

Les Fertig and Jack Herron, assistant basketball coaches at the University of Oklahoma in Norman, Oklahoma, made the following comments about left-handed players whom they have coached;

> ". . . Jack (Herron) and I (Les Fertig) discussed the left-handed basketball player at great length . . . it seems to us in thinking back about left-handed basketball players we have been associated with and coached that left-handed basketball players are nearly always one-handed (left) basketball players

> . . . this was thought to be more of a disadvantage in the past than it is today . . . left-handed players have or seem to have a very poor shot selction from the left as opposed to the right-handed player to the left . . . it might just be that because they are left-handed they stand out more . . ."

James King, head basketball coach at the University of Tulsa in Tulsa, Oklahoma, (former professional player with the Chicago Bulls and Los Angelos Lakers), made the following comments about defensing left-handed basketball players.

> ". . . I've played with and been associated with many fine left-handed basketball players. They seem to me to be very difficult to guard because of their unorthodox manner of shooting the ball . . . I feel that one of the primary reasons Gail Goodrich (Golden State Warriors) has been so successful in the pro's, is because of his being left-handed . . . most players are accustomed to covering a player to his right, this creates a problem in defending Gail . . . Larry Wilkens of the Portland Trail Blazers is another very exceptional left-handed player . . . even though you know what he is going to do he's difficult to defense. . . left-handed players seem to me to be much more left-handed than right-handed ball players (are right-handed) . . . it may be that right-handed players are also in the same situation, but because they are in the majority we don't notice it so much . . . Jerry West, former professional player with the Los Angelos Lakers, noted at a basketball camp a few years ago that he only shot two left-handed lay-ups in his entire career as a professional player . . ." (Jerry West is a right-handed basketball player) (Parentheses materials added)

Paul Hansen, head basketball coach at Oklahoma

City University in Oklahoma City, Oklahoma, also noticed the extreme left-handedness of left-handed players.

> ". . . I can't give any factual information but it's always seemed to me that the right-handed ball player can go to his left easier than a left-handed player can go to his right . . . I noticed no problems in left-handed players learning various offenses . . ."

Guy Strong, head basketball coach at Oklahoma State University in Stillwater, Oklahoma, made the following comment about left-handed players.

> ". . . I've coached several excellent left-handed players in fact I try to actively recruit left-handed guards because they will provide more balance by entering the ball more from the left-side of the floor . . . the flow of the basketball is to the right about 75% of the time. We find that with a left-handed guard this is evened out some. I have noticed no learning problems experienced by left-handed players . . . they do seem to be more one handed than their right-handed teammates . . ."

Wayne Cobb, head basketball coach at Murray State College in Tishomingo, Oklahoma, felt that basketball offenses were designed for the right-handed athelete.

> ". . . most offenses it seems to me are designed with the right-handed player in mind, the flow of the ball is generally more to the right than the left. Most basketball offenses are designed with the right-handed player in mind. The flow of the basketball is to the right (McLane, 1965) (Wooden, 1966) and most options develop with the player coming from the weak side, to the strong side to the ball in a left-to-right movement. I feel that if a player starts early and works hard with both hands he can develop proficiency going in either direction . . . most left-handed players will seldom go in the opposite direction, while

right-handed players will learn to go to the basket with their left-hand."

Arlan Beadles, head basketball coach at Midwest City High School in Midwest City, Oklahoma, makes the following comments.

> ". . . left-handed players can't go right as well as right-handed players can go left . . . they don't seem to experience any difficulty in learning the offense . . . I've coached some good left-handed players who could use either hand . . ."

Ronnie Cox, head basketball coach at Bacone College in Muskogee, Oklahoma, noted the unorthodox style of shooting in the following comments.

> ". . . the differences I've noticed with left-handed basketball players is in the area of their shooting the basketball . . . the left-hander seems to develop a more unorthodox manner of shooting the ball, the wrist action seems hard to master and they put the wrong spin on the ball . . . the left-hander does give you a different type of strength when the flow of the ball is to the left . . . the left-handed player learns his basketball most of the time from a right-handed coach, this provides him with an inappropriate model . . ."

Gene Wallace, head basketball coach at Oklahoma Baptist University in Shawnee, Oklahoma, commented on the shooting style of left-handed basketball players in the following passage.

> ". . . most left-handers I've coached were good offensive basketball players . . . it seems most left-handers have a wider selection of shots and are somewhat more unorthodox in their shooting . . ."

Carl Scott, head basketball coach at Connors State College in Warner, Oklahoma, indicated that he had noticed no real differences in coaching right- and left-handed atheletes.

> ". . . I never had any real problem in coaching left-handers . . . I use articles and pictures to teach correct shooting form . . . its difficult for a right-handed coach to demonstrate a left-handed skill . .. the left-handers I've coached never had any problem learning various processes we use or offenses . . ."

Enos Semore, head baseball coach at the University of Oklahoma, Norman, Oklahoma made the following statement about left-handed baseball players.

> ". . . I try to accent each player as he is, left or right-handed . . . I don't try to change him. The left-hander is limited somewhat in baseball as to the positions he can play. For example, he can't play in the in-field except as a pitcher or first baseman . . . he is very limited as a catcher and third baseman . . . the old saying that left-handed pitchers are wild is not true . . . one of the biggest problems I have in working with left-handers is demonstrating correct form since I'm (Coach Semore) right-handed. This is especially true when I'm working with left-handed pitchers. Right-handed models (coaches) have somewhat of an adjustment problem in teaching left-handers. (Parentheses material added for clarification)

Jim Morris, assistant basketball coach, Indiana State University at Terra Haute, Indiana made the

following comments about left-handed basketball players.

> ". . . most true left-handers I've coached have had a very difficult time learning to develop any kind of proficiency with their opposite (right) hand, whereas the right-handed player adapts or seems to adapt much more quickly to the use of his left hand. I really don't know why this seems to be true but it has been my experience as a coach. This may be because the right-handed coach has a difficult time teaching in the opposite direction."

Bill Kusleika, former assistant basketball coach at the University of Tulsa in Tulsa, Oklahoma also commented on left-handed atheletes.

> ". . . left-handed basketball players who work hard seem to overcome their handedness problems . . . that is to say that the good athlete adjusts to the situation and becomes proficient with either hand, regardless of whether he is right or left-handed . . . I think the real question you have to deal with is how dedicated is the athlete. If a young man really wants to become a success he will over come his handedness' problems . . ."