AN INVESTIGATION OF SIMPLE REACTION TIME AND MOVEMENT TIME OF THE DOMINANT AND NON-DOMINANT HAND OF ELEMENTARY SCHOOL CHILDREN

APPROVED:

[Signature]
Major Professor

[Signature]
Minor Professor

[Signature]
Director, Department of Health, Physical Education, and Recreation

[Signature]
Dean of the Graduate School

The purpose of this study was to investigate the reaction time and speed of movement of the dominant and non-dominant arms of elementary-school boys and girls. The 192 children were arranged in four groups, according to age, with forty-eight subjects in each age group from eight through eleven years. Each subject performed eight trials of the task with each arm, and the mean of the eight trials was used in the analysis of the data.

The apparatus was designed specifically to measure reaction time and movement time. It consisted of two clocks, calculated to the nearest one-hundredth of a second, two high-speed photo-electric relay units, a stimulus light, a control switch, and a reaction time button. These instruments were mounted on a plywood platform twenty-seven inches from the floor. A light-weight plywood handle was held by the subject to make sure the photo-light beam was broken by the hand in measuring movement time.

A test to measure simple reaction time and speed of movement was administered to each subject using the test instrument previously described. The tests were administered at Cannon
Elementary School, Grapevine, Texas during the school day. All testing was completed during the month of May, 1971.

The testing began with the lowest age group, and only one subject was in the testing area at a time. Two practice trials were allowed each subject after a complete explanation and demonstration of the task procedure. Half of the subjects began the testing with the dominant hand, and half of the subjects began with the non-dominant hand.

Each subject was given eight trials with the dominant hand and eight trials with the non-dominant hand. The score for each trial was recorded to the nearest one-hundredth of a second.

The means of the eight trials were computed, and the data were organized in such a manner to be treated statistically. The level of significance was set at the .05 level for all computations. An analysis of variance was computed to determine if significant differences existed between means. Duncan's Multiple Range Test was selected to identify areas of significance between ages. The t-test was used to determine the significance of the differences between means for dominant and non-dominant arms in both reaction time and movement time for each age level.

The Pearson product-moment correlation was computed to indicate the relationship between reaction time and movement time of all ages. This measure was also computed to indicate
the relationship between dominant and non-dominant reaction
time and dominant and non-dominant movement time of all ages.

Conclusions

The findings would seem to warrant the following con-
cclusions concerning reaction time and movement time of the
dominant and non-dominant arms of elementary-school children:

1. Both reaction time and movement time improve consist-
tently from ages eight to eleven.

2. Eleven-year-olds perform better in skills involving
reaction time and movement time than do children ages eight
through ten.

3. Youngsters ages eight through eleven perform equally
well with either the dominant or non-dominant arm in skills
involving reaction time.

4. Youngsters ages eight through eleven perform better
with the dominant arm than the non-dominant arm in skills
involving speed of movement.

5. The relationship between reaction time and movement
time, though statistically significant in two of the four ages,
is relatively low and not great enough for predictive purposes.

6. There is a positive relationship between the dominant
and non-dominant arms in both reaction time and movement time
for elementary-school children.

In comparing the means between reaction time and movement
time of the dominant and non-dominant arms, this study indicates
that these variables are slowly improving functions of age in elementary-school children.

Recommendations

It is recommended that this type of study be performed on an older age group to see if reaction time and movement time continue to improve.

Also it is recommended that a more complex task to measure reaction time and movement time be used with the possibility that it may produce a greater difference between dominant and non-dominant arms.
AN INVESTIGATION OF SIMPLE REACTION TIME AND MOVEMENT TIME OF THE DOMINANT AND NON-DOMINANT HAND OF ELEMENTARY SCHOOL CHILDREN

THESIS

Presented to the Graduate Council of the North Texas State University in Partial Fulfillment of the Requirements For the Degree of

MASTER OF SCIENCE

By

Horace H. Bartee, B. A.

Denton, Texas

August, 1971
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>iv</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF ILLUSTRATIONS</td>
<td>v</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td></td>
</tr>
<tr>
<td>Purposes of the Study</td>
<td></td>
</tr>
<tr>
<td>Definition of Terms</td>
<td></td>
</tr>
<tr>
<td>II. REVIEW OF LITERATURE</td>
<td>6</td>
</tr>
<tr>
<td>III. PROCEDURES</td>
<td>22</td>
</tr>
<tr>
<td>Subjects</td>
<td></td>
</tr>
<tr>
<td>Testing Instruments</td>
<td></td>
</tr>
<tr>
<td>Test Administration</td>
<td></td>
</tr>
<tr>
<td>IV. ANALYSIS OF DATA</td>
<td>28</td>
</tr>
<tr>
<td>Summary of the Findings</td>
<td></td>
</tr>
<tr>
<td>V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS</td>
<td>42</td>
</tr>
<tr>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
</tr>
<tr>
<td>APPENDIX</td>
<td>46</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>48</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table                                                                 Page

I. Random Selection of Time Intervals Before On-Set of Stimulus Light ........ 27

II. Means and Standard Deviations of Reaction Time and Movement Time of Dominant and Non-Dominant Arms. ................ 29

III. Summary Table for Analysis of Variance for Dominant Reaction Time (N=192) ... 30

IV. Summary Table for Analysis of Variance for Dominant Movement Time (N=192) ... 30

V. Summary Table for Analysis of Variance for Non-Dominant Reaction Time (N=192) ... 31

VI. Summary Table for Analysis of Variance for Non-Dominant Movement Time (N=192) ... 32

VII. Duncan's Multiple Range Scale for Differences Between Means for All Groups ... 33

VIII. Means, Standard Deviations, Mean Differences and t Values for Differences in Reaction Times ......... 35

IX. Means, Standard Deviations, Mean Differences and t Values for Differences in Movement Times ............. 36

X. Correlation Coefficients Between Reaction Time and Movement Time by Dominance and Age ... 38
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Starting Position for Reaction Time - Movement Time Test.</td>
<td>24</td>
</tr>
<tr>
<td>2.</td>
<td>Finish Position for Reaction Time - Movement Time Test.</td>
<td>24</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

The amount of published research indicates that physical educators have been interested in reaction time and speed of movement since the middle of the nineteenth century. Many of the studies reported during the early part of the present century involved investigation of the relationship of reaction time and speed of movement with various sports events such as track, wrestling, football, and baseball. One such study, reported by Westerlund and Tuttle\(^1\) in the early 1930's, investigated the relationship between the speed of running events in track and reaction time.

Education is only one field in which there has been an interest in reaction time and movement time. Behavioral scientists have also been vitally interested in measuring human response latency. Goodenough stated that the problem was of theoretical interest since "the speed with which an individual is able to make a simple motor response to a perceived stimulus may fairly be regarded as a significant index to his basic level of perceptual-motor integration."\(^2\)

\(^1\)H. H. Westerlund and W. W. Tuttle, "Relationship Between Running Events in Track and Reaction Time," Research Quarterly, II (October, 1931), 95-100.

The study of reaction time and speed of movement is but one area of concern to educators. Also of interest to researchers and educators is the phenomenon of human handedness. A large number of investigations have been carried out with the aim of answering various questions which are raised concerning the relation of a person’s hands to each other.

Kephart, for example, expressed concern about children being too one-sided in their development. He emphasized that the child who is totally unilateral in his responses to movement problems will experience more or less the same learning difficulties as the youngster who remains frozen at the bilateral level. Kephart also pointed out that "in either of these two cases, the child restricts his movement patterns and restricts his learning. He does not gain an adequate appreciation of right and left and confronted with problems of laterality in external space, he will reflect his difficulty by confusing the two directions."

Kephart has principally associated his studies with the relationship between laterality and academic success, whereas Davis and Logan discussed the effects of being too one-sided upon posture and body mechanics. Davis and Logan reflected upon conditions of handedness by saying,

---

3Newell Kephart, The Slow Learner in the Classroom (Columbus, Ohio, 1960), p. 44.

4Ibid.
Recently it has been proposed that in order to prevent unilateral or one-sided development of the body of the school child, the activities in which the child participates should be organized in such a way that the child will of necessity use both sides equally. It is generally known that the person develops handedness and the muscles on that side of the body will become larger, the bones will be heavier, and the shoulder will tend to be lower on that side, due to the increase in the weight of the structure. This increased weight in turn causes an adaptative shift in the weight of the trunk to conform to the line of the pull of gravity. Those individuals who believe that any degree of deviation in the spinal column will result in degenerative changes in later life, advocate that these slight differences should not be allowed to occur.  

Numerous studies indicate that it is desirable for the individual to learn ambidexterity in the performance of particular skills because of the definite advantage of being able to use both hands or both feet skillfully. Way, for example, stated that motor ability is related to foot ambidexterity. She proposed that women who have mixed eye, hand, and foot dominance are superior in motor ability to those who are totally one-sided. Lambert stated that the majority of evidence suggests that practice with both hands or both feet should proceed simultaneously.

5Elwood C. Davis and Gene A. Logan, Biophysical Values of Muscular Activity with Implications for Research (Dubuque, Iowa, 1969), p. 56.


Statement of the Problem

The literature indicates the need for individuals to possess the ability to function effectively with both dominant and non-dominant hands. Gesell and Ames\(^8\) conducted a study of eight children for several years as handedness was being developed. They found that the development of lateral dominance does not follow a straight course but fluctuates periodically, and that laterality is established by about eight years of age.

This study investigated the relationship of reaction time and movement time of boys and girls, ages eight through eleven. While the investigation was concerned with furthering the knowledge of the relation of these two variables, it was primarily concerned with an investigation of reaction time and movement time of dominant and non-dominant arms of boys and girls and the difference at each age.

Purposes of the Study

The purpose of this study was to investigate the relationship between simple reaction time and movement time of the arm, through a prescribed distance, of boys and girls ages eight through eleven. An additional purpose was to investigate the relationship of simple reaction time and movement time of the preferred and non-preferred arm of boys and girls, ages eight through eleven.

Definition of Terms

To help clarify the use of certain terms in this study, the following definitions are given:

1. **Simple Reaction Time**.--The time elapsed between the presentation of the stimulus and the initiation of movement. In this study reaction time was the time measured in hundredths of a second between the appearance of a light stimulus and the release of a reaction time button.

2. **Movement Time**.--The time interval between the beginning and the completion of the specified movement. In this study movement time was the time elapsed between the initiation of movement and completion of movement of extending the arm nineteen inches.

3. **Dominance**.--"The habitual use, in unilateral motor task, of one hand, foot, or eye in preference to the opposite number." Dominance as used in this study referred to the preferred use of the right or left hand determined by a test of handedness.

---

A review of the literature revealed that a number of investigations have been conducted concerning various aspects of the relationship between reaction time and movement time. The interest of students and teachers in the phenomenon of human handedness is evidenced by the fact that it has been investigated in a number of ways.

To facilitate an orderly presentation, the related literature was organized in the following manner:

1. Studies suggesting the existence of a relationship between reaction time and speed of movement.

2. Studies indicating the absence of a relationship between reaction time and speed of movement.

3. Studies concerning the area of dominant musculature or handedness.

In an early study Lewis\(^1\) investigated the relationship between simple reaction time and speed of flexion and extension of both arms in four groups of subjects, i.e., American men and women, male Negroes, and Indians. After analyzing the data it was concluded that a close relationship existed between

\(^1\)A. L. Lewis, "Comparison of the Times of Simple Reactions and of Free Arm Movements in Different Classes of Persons," Psychological Review, IV (1897), 113-114.
simple reaction time and speed of movement. Since no statistics were presented in the report, the conclusion should be viewed with some reservation.

Westerlund and Tuttle\textsuperscript{2} used twenty-two University of Iowa track men in an investigation of the relationship between speed of running events in track and reaction time. The speed of movement measure involved was a seventy-five yard sprint, and the reaction time recorded was a simple finger response to a light stimulus. Making up the group of subjects were six sprinters, nine middle distance men, and seven distance men. Three of the subjects, two sprinters and one middle distance runner, were outstanding enough to be considered champion runners. The results revealed that the champions, as a group, reacted faster than all other groups. Also, the sprinters responded faster than the middle distance men, and the middle distance men in turn responded faster than the distance group. A correlation of .86 was found between speed of running seventy-five yards and simple reaction time. In view of this relatively high correlation the authors concluded that a high positive relationship existed between reaction time and movement time.

Beise and Peaseley\textsuperscript{3} measured forty-seven women who were skilled in golf, tennis, and archery and fourteen unskilled

\textsuperscript{2}Westerlund and Tuttle, pp. 95-100.

\textsuperscript{3}Dorothy Beise and Virginia Peaseley, "The Relationship of Reaction Time, Speed and Agility of Big Muscle Groups to Certain Sports Skills," Research Quarterly, VIII (March, 1937), 133-142.
performers in large muscle reaction time and speed of movement.
The reaction time measure involved arm and leg movements in
depressing and releasing pressure on a floor plate in response
to a light stimulus. A timed sprint of seventeen feet ten
inches from a standing start was the speed of movement measure
utilized. While correlations between reaction time and move-
ment time were not included in the study, it should be noted
that the authors found the skilled performers to be faster in
both reaction time and speed of movement than the unskilled

group.

The reaction time of 247 male high school students between
fourteen and seventeen years of age was investigated by Atwell
and Elbel. There were two response measures recorded, a hand
response which involved striking a hand switch upon presentation
of a stimulus bell and a body response which involved lunging
forward a distance equal to the height of the subject and striking
a padded contact. Low, but significant, correlations ranging
from .24 to .43 were found between the two response measures.

Several tests have been devised in the area of psycho-
logical testing to secure a speed of movement measure. Among
these is a test involving tapping a pencil as rapidly as
possible for a prescribed time and determining the speed of
movement by the number of marks made during the interval.

\[^{4}\text{W. O. Atwell and E. R. Elbel, "Reaction Time of Male}
\text{High School Students in Fourteen-Seventeen Age Groups,}
\text{Research Quarterly, VII (March, 1946), 22-23.}\]
Lainer utilized such a test and reported a significant correlation of .50 between the tapping test and a simple reaction time.

Miles, in a study of the relationship of reaction and coordination speed, used a movement test which involved the rapidity with which a subject could reach and move a pencil from one hole to another and return the hand used to a starting key. Low correlations of .24 to .30 were obtained between this test and simple reaction time and no conclusions were made as to their significance.

In one of the few studies which dealt with women subjects Youngen compared reaction time and movement time of women athletes and non-athletes. The non-athletic group was composed of seventy-five women and the athletic group consisted of forty-seven women. She found that women athletes were significantly faster than the non-athletes in both reaction time and speed of movement. She also reported a significant correlation between reaction time and movement time.

In summarizing the studies suggesting a relationship between reaction time and speed of movement, it would appear


that in some cases questionable conclusions were made since several of the studies involved very small and select groups. Furthermore, the measures of reaction time and/or rate of movement were often of a highly coordinated nature. In spite of these shortcomings, the possibility of a positive relationship between the two variables could not be ruled out completely.

In contrast to the studies suggesting the existence of a relationship between speed of movement and reaction time, there were a number of more recent investigations which indicated the two measures to be independent and unrelated.

Henry and Trafton\(^8\) measured twenty-five physical education majors on simple reaction time and a timed fifty-yard sprint and reported a correlation of .14 between the two measures. In view of the non-significant correlation they concluded that since the correlation was not significant, fast reactors are not necessarily fast runners. They also concluded that reaction time could be neglected as a factor in sprints after the first ten to fifteen yards.

In another study involving eighteen subjects, Henry\(^9\) correlated individual reaction times of a simple response nature and speed of running fifty yards. The resulting correlation of .18 was reported as non-significant.

---


A third investigation by Henry\textsuperscript{10} involved sixty subjects in a ball snatch and treadle press test. As in his other studies, non-significant correlations ranging from .07 to .15 were reported. The conclusion was made that reaction and movement functions are independent and uncorrelated. It should be noted that the two movements measured involved a terminal adjustment: grabbing a suspended ball and pressing a hand treadle. Under these conditions the results might well be due to the fact that the terminal adjustment resulted in deceleration of the limb.

Slater-Hammel\textsuperscript{11} attempted to measure reaction time and speed of a free arm movement. Using twenty-five physical education majors as subjects, recordings were made of both halves of a free arm movement through an arc of 120 degrees. The reaction time measure preceded the movement and involved release of pressure on a reaction key with the arm movement continuing through the arc. The correlations ranged from -.07 to .17, and the conclusion was made that reaction time and movement time were independent and unrelated. As with Henry's studies, the number of subjects was small and the arm movement required striking a gate device midway through the arc and slamming the hand into a padded terminal contact to record the

\textsuperscript{10}Franklin Henry, "Independence of Reaction and Movement Times and Equivalence of Sensory Motivators of Faster Response," Research Quarterly, XXIII (March, 1952), 43-53.

end of the movement. The question might well be raised as to whether there was decleration before striking either the gate or the terminal contact.

Rarick\textsuperscript{12} investigated the relationship between reaction time of the triceps muscle and the gastrocnemius muscle and speed of running the last ten yards of a thirty-yard sprint. With fifty-one physical education majors serving as subjects, correlations between triceps reaction time and two identical sprint measures were found to be -.13 and .08. Correlations between reaction time of the gastrocnemius and the same two sprint measures were -.15 and -.19 respectively. The reaction time measure was not described in the study and specific conclusions regarding the non-significant correlations were not presented.

In an investigation of speed of reaction time and speed of movement of the hand and foot, Fairclough\textsuperscript{13} secured measurements from forty male physical education majors. The movements were of a coordinated type involving a terminal adjustment in the hand movement and ninety degree change of direction in the foot movement. As in the previous studies involving movement measures of a similar nature, non-significant correlations were reported.

\textsuperscript{12}Lawrence Rarick, "Analysis of the Speed Factor in Simple Athletic Activities," \textit{Research Quarterly}, VIII (December, 1937), 89-105.

Henry and Rogers\textsuperscript{14} reported that reaction time was determined by the nature and complexity of a stored "neuromotor program" or motor memory that required time to be selected and processed to the motor nerves. They stated that for learned actions, the foreperiod interval provided time for voluntary consideration of the movement, thus allowing the act to be accomplished at a maximum speed. Therefore "the crucial willful act in the simple reaction time is the release of the outburst of neural impulses that will result in the movement."\textsuperscript{15}

It was further theorized that learned neuromuscular coordination patterns were believed to be stored. They then become accessible for use in controlling the act by a "memory drum" mechanism that requires time to be put into action. Speed of movement, however, was theoretically determined by a different fact, namely strength in action, which was controlled by the effectiveness of the program in causing the appropriate muscles to create or apply force to the limbs to cause movement.

In 1961, Henry\textsuperscript{16} reported data obtained from 400 male and female subjects. In tests of speed of reaction and movement


\textsuperscript{15}\textit{Ibid.}, p. 449.

to auditory and visual stimuli he concluded that there was no significant difference between males and females in reaction time. He also stated that there was no theoretical reason why there should be a difference between the two. Women were found to be significantly slower than men in speed of movement, and the younger subjects were slower than adults in both reaction time and movement times.

Hodgkins, in an extensive study of 930 men, women, and children investigated differences between reaction time and movement time of males and females of various ages. In response to a visual stimulus, reaction was determined by removing the hand from a telegrapher's key. Speed of movement was then timed from the end of reaction until the subjects hit a terminating rod. It was reported at the first grade level that there was no significant difference between males and females in reaction time. Between the ages of twelve and fifty-four, males were significantly faster than females in both reaction time and movement time.

The relationship between reaction time and movement time has been investigated many times. Generally it has been found to have a very low correlation leading to the conclusion that the two variables are unrelated and independent. Two relatively

recent studies contradict this conclusion. Pierson and Youngen reported significant correlations between the two variables.

In a later study Mendryk reinvestigated those age groups for which significant relationships had been reported by Pierson and Youngen. He tested 150 males ages twelve, twenty-two, and forty-eight years in reaction time to a visual stimulus and found that none of the correlations were significant.

Henry commented on this difference in findings stating that, under certain circumstances, outside mechanisms might cause observed reaction time-movement time correlations to deviate from zero. Also, by sampling error alone, an occasional statistically significant correlation must be expected.

In summarizing these studies, it would appear that the more recent investigations have presented more statistical data from which to draw conclusions. Most of these investigators have concluded that reaction time and movement time are independent and unrelated variables. Terminal deceleration could have been a factor in these conclusions. Also several

---


of these studies involved small select groups as did some of the studies suggesting a relationship of these variables.

In the area of dominant musculature or handedness the following studies were investigated. Lambert\textsuperscript{22} undertook a study to determine which was a more efficient method: teaching the subject to master the use of his non-dominant musculature first with instruction given to his dominant musculature later, or teaching him to use his dominant musculature first and then his non-dominant musculature in acquiring two-handed skills.

Fifty college men ranging in age from nineteen through twenty-five served as subjects. The subjects were selected on the basis of their responses to a questionnaire concerning handedness. The apparatus consisted of a psychomotor test involving the lifting of washers off of a peg and placing them on another peg seen through a mirror, following a pre-determined sequence of movements. The fifty subjects were divided into two groups. Subjects comprising Group A, after completing a two-handed skill test, were given forty practice trials using only the non-dominant hand during a two week period and then were retested. Subjects comprising Group B, after a similar initial test, were given the same number of practice trials using the dominant hand and then were retested.

At the completion of the experiment, Lambert drew the following conclusions: The learning curves suggested that more

\textsuperscript{22}Lambert, \textit{op. cit.}
learning took place in the non-dominant group than in the dominant group, there seemed to be little difference as to which hand was trained first in learning a two-handed skill, and an interference effect resulting in poorer performance resulted from switching from the single-handed performance to the double-handed performance. This finding suggested that the most efficient method of training might be to give equal attention to both musculatures at the same time rather than practicing first with either the dominant or the non-dominant hand.

Knoppers undertook a study to determine the influence of contralateral practice upon the performance of the over-arm throw for accuracy by forty-nine women volunteers enrolled in Texas Women's University in Denton, Texas, during the first summer session (1967-1968). The subjects were assigned at random to one of three groups. Students in one group practiced the skill with the left hand only; students in a second group practiced the skill with the right hand only; students in the third group refrained from practice throughout the duration of the experimental period which consisted of eight sessions. The influence of each type of treatment was measured through the administration of the initial and final tests of the overarm throw for accuracy with the dominant arm.

The data which were collected included scores from the initial and final test of the overarm throw for accuracy as well as the scores for the first two and last two practice sessions. There was no significant difference between the three groups at the onset of the experimental period as was evidenced by the result of the application of Bartlett's Test of Homogeneity of Variance. A significant difference between the scores during the first two and the last two practice sessions indicated that both practice groups had improved significantly under the practice conditions. The application of Duncan's Range Test to the initial and the final mean scores of all of the groups indicated that the only significant change that occurred was that between the initial and final test scores of the group which practiced with the right arm. Knoppers concluded that there was no bilateral transfer in the performance of the overarm throw for accuracy with the dominant hand after a period of practice with the non-dominant hand.

Grundlingh-Malan conducted a study to ascertain to what extent an approximate ambidexterity can be attained by means of a regular practice with both arms, and second, how much an attainment affects the organism with regard to throwing ability in general, symmetry of posture, and mental development as far as it can be inferred from marks obtained at school.

Two groups, each comprised of twenty-five students enrolled at the Orange Free State School, served as subject for one year. The groups were comprised of boys and girls with right-handedness equally predominating in both. At the beginning of the study, the average age of the children in the experimental group was eight years and two months and that of the children in the control group was eight years and eight months.

For six months prior to the initiation of the experiment, the children in the experimental group were gradually accustomed to carrying their books in the inferior hand and to do simple routine activities with it. When this phase of the study was completed, both groups, in their physical education classes, practiced cricketball throwing for distance as well as at targets and played the same type of ball games. The children of the control group were allowed to give preference in the usual way to the better hand, while those of the experimental group were systematically taught to employ their left hand and right hand equally in all activities. All of the children were tested with regard to either hand and examined with respect to symmetry of posture at the beginning of the experiment by the school physician.

The investigator drew the following conclusions in regard to the experiment. Exercising the dominant arm as such does not promote the development of the other arm. As one grows older, the difference between the right and left arm increases and so does the symmetry of posture unless the inferior side is trained
at least in the execution of gross activities. By training
the inferior arm gains are significant within a comparatively
short while, especially in the development of strength, and also
in the symmetry of posture. The resulting development of the
inferior arm does not interfere with that of the superior one.
Finally, the attainment of an approximate ambidexterity has no
detrimental effect whatsoever upon mental development.

Way undertook a study to investigate the incidence of
various laterality preferences among college women to determine
the relationship of lateral dominance with general motor ability
and to determine the relationship of laterality with skill test
scores in archery, badminton, bowling, and tennis. The study
was limited to 110 sophomore and junior women enrolled in the
required program of physical education at the University of
Washington. All of the subjects were between the ages of seven-
teen and twenty-five.

The tests used in the study were the Scott Motor Ability
Test to determine the competency of each subject in sports
skills, the Kilg A-B-C Test of Ocular Dominance to determine
the unconscious eye preference of each subject, a modification
of the Johnson Dartboard Test to determine the degree of dex-
terity of each hand, and the Turner Footedness Test to determine
the degree of dexterity of each foot. Skill test scores in the
physical education activities were obtained in different ways.

---

Frequency distributions and histograms of the scores on eye dominance, hand dexterity, and foot dexterity were made. Laterality groups were compared to determine the significance of the difference between the mean scores for the general motor ability test. Combinations of two of the variables were classified as pure and mixed dominance. Subjects having the same preference for three variables were termed homolaterals. Those subjects who had the same preference for two variables and a different preference for the third were called contralaterals. Subjects who had a different preference for each variable were classified as having mixed preference.

All differences between the mean scores of motor ability were tested by the $t$-ratio to determine the significance of the difference. The investigator drew the following conclusion in regard to the experiment: Women who had mixed eye, hand, and foot dominance were superior in motor ability to those who had homolateral or contralateral preference.

In conclusion, studies associated with dominance have covered many areas including bilateral transfer of skills, posture effects, contralateral practice effects, mental development and skill development. Each of these studies has contributed to the available information concerning dominance.
CHAPTER III

PROCEDURES

In this chapter are procedures which were used for the development of the study to investigate reaction time and speed of movement of the dominant and non-dominant arms of elementary school children.

Subjects

The subjects for this study were 192 boys and girls, ages eight through eleven, who attended Cannon Elementary School in Grapevine, Texas. There were 450 potential subjects who ranged in age from seven years six months to eleven years six months. To determine age for this study a subject was considered to be a specific age if at the time of testing he was within six months of his birthday. For example, a child was considered an eight-year-old if he was between seven years seven months and eight years six months old. The potential subjects were divided into four groups according to age. The youngest group consisted of eight-year-olds and the oldest was composed of eleven-year-old pupils. Twenty-four boys and twenty-four girls were randomly selected from each age group to serve as subjects.

Testing Instruments

The apparatus used for this study was designed to measure reaction time and movement time during the performance of a
single task. The instrument tested reaction time to a light stimulus and movement time in extension of the arm. It was designed in such a manner that performance with the apparatus did not require terminal deceleration.

The instruments included as parts of the apparatus were two clocks, calculated to the nearest one-hundredth of a second, two high speed photo electric relay units, a stimulus light, a control switch, and a reaction time button. These instruments were mounted on a plywood platform as shown in Appendix A. The platform rested on a table and was twenty-seven inches from the floor. A light-weight plywood handle three and one-half inches wide and six inches long was also considered part of the apparatus. This handle was held by the subject to make sure the photo-light beam was broken by the hand in measuring movement time.

For testing, the subject stood, as shown in Figure 1, holding the plywood handle and depressed a micro-switch. When the control switch was depressed, a stimulus light across the table from the subject was turned on, and the reaction timer was started. The subject moved the plywood handle from the switch which stopped the reaction timer and recorded reaction time. As a continuation of the movement, the subject extended the arm vigorously as shown in Figure 2. As the arm passed a point four and one-half inches from the starting position, the hand with the plywood handle broke a light beam which started the movement timer. The subject continued the arm extension and when the
hand holding the plywood handle passed the second light beam located nineteen inches from the first light beam, it stopped the movement timer.

Figure 1--Starting Position

Figure 2--Finish Position
Before the reaction time and movement time test was administered, each subject was given a test to determine hand dominance. According to Oxendine,

1 dominance is exhibited in many motor tasks. People exhibit sidedness in smiling, chewing, winking, sleeping positions, handling eating utensils, and many small manual skills.

A technique for determining functional handedness, footedness or eyedness is to have the individual actually perform tasks as the investigator observes. "This will provide information regarding functional dominance in cases where it cannot be given by the individual verbally." 2

In this study a series of tests was given to each individual to determine the preferred hand in tasks which necessitated the use of either hand. The tests used for this study were a battery of ten established by Belmont and Birch. 3 The hand preference tests were administered one week before the reaction time and movement time testing began. Instructions for these hand preference tests are shown in Appendix B.

Test Administration

A test to measure simple reaction time and speed of movement was administered to each subject using the test instrument

2 Ibid., p. 309.
previously described. The tests were administered at Cannon Elementary School during the school day. All testing was completed during the month of May, 1971.

The reaction time and speed of movement test was administered by one person, and the scores were recorded by a teacher assistant. The testing began with the lowest age group, and only one subject was in the testing area at a time. The remaining subjects were seated outside the testing room to avoid extraneous auditory and visual distractions.

Each subject was allowed two practice trials with each hand after a complete explanation and demonstration of the task procedure. Half the subjects began the testing with the preferred hand, and half the subjects began the testing with the non-preferred hand. Subjects were randomly assigned the hand they used at the beginning of the testing.

Each subject was given eight trials with the preferred or dominant hand and eight trials with the non-preferred or non-dominant hand. Each subject performed the eight trials for each hand in one session. The score for each trial was recorded to the nearest one-hundredth of a second.

While being tested, the subject stood with the shoulder of the hand being tested over the reaction time button and depressed the reaction time button with the wooden handle. A verbal "ready" signal was given, and then the subject moved at the on-set of the light stimulus. The time lapse between the verbal ready signal and the on-set of the stimulus light varied
from one second to four seconds, but was the same for all subjects. A random selection of time intervals from one to four seconds was assigned to each trial. These time intervals are reported in Table I. The tester held the control button behind his back while standing to one side so as not to distract the subject.

TABLE I

RANDOM SELECTION OF TIME INTERVALS BEFORE ON-SET OF STIMULUS LIGHT

<table>
<thead>
<tr>
<th>Trial</th>
<th>Seconds</th>
<th>Trial</th>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>
CHAPTER IV

ANALYSIS OF DATA

A test of reaction time and speed of movement of the dominant and non-dominant arm was administered to 192 subjects from four age groups. Eight trials were recorded with the dominant arm and eight trials were recorded with the non-dominant arm. The scores of the dominant arm reaction time (DRT), dominant arm movement time (DMT), non-dominant arm reaction time (NRT), and non-dominant arm movement time (NMT) were organized in such a manner that they would be treated statistically. Since the variable in reaction time and movement time is speed, the lower score will indicate the better time.

The means and standard deviations at each age level of these four groups are found in Table II.

To determine whether or not the differences between the means of the four groups were statistically significant, an analysis of variance, as described by Lordahl,\(^1\) was computed. The level of significance was set at the .05 level. The summary table for the analysis of variance of dominant reaction time of the four age groups is presented in Table III.

TABLE II
MEANS AND STANDARD DEVIATIONS OF REACTION TIME AND MOVEMENT TIME OF DOMINANT AND NON-DOMINANT ARMS

<table>
<thead>
<tr>
<th>Age</th>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (N=48)</td>
<td>DRT</td>
<td>0.27</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td>0.28</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td>0.14</td>
<td>0.01</td>
</tr>
<tr>
<td>9 (N=48)</td>
<td>DRT</td>
<td>0.26</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>0.12</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td>10 (N=48)</td>
<td>DRT</td>
<td>0.22</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td>0.21</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td>0.11</td>
<td>0.03</td>
</tr>
<tr>
<td>11 (N=48)</td>
<td>DRT</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>0.12</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>NMT</td>
<td>0.13</td>
<td>0.04</td>
</tr>
</tbody>
</table>
TABLE III

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR DOMINANT REACTION TIME (N=192)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sums of Squares</th>
<th>Degrees of Freedom</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>.08</td>
<td>3</td>
<td>12.80*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>.39</td>
<td>188</td>
<td>.......</td>
</tr>
<tr>
<td>Total</td>
<td>.47</td>
<td>191</td>
<td>.......</td>
</tr>
</tbody>
</table>

*Significant at the .05 level.

The results reported in Table III indicate that at least one of the differences between means is great enough to be statistically significant at the .05 level.

In Table IV is reported the summary table for the analysis of variance for dominant movement time of the four age groups.

TABLE IV

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR DOMINANT MOVEMENT TIME (N=192)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sums of Squares</th>
<th>Degrees of Freedom</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>.04</td>
<td>3</td>
<td>13.34*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>.19</td>
<td>188</td>
<td>.......</td>
</tr>
<tr>
<td>Total</td>
<td>.23</td>
<td>191</td>
<td>.......</td>
</tr>
</tbody>
</table>

*Significant at the .05 level.
Examination of Table IV indicates that at least one of the differences between means is great enough to be statistically significant at the .05 level.

In Table V the summary table for the analysis of variance for non-dominant reaction time of the four age groups is reported.

**TABLE V**

SUMMARY TABLE FOR ANALYSIS OF VARIANCE FOR NON-DOMINANT REACTION TIME (N=192)

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sums of Squares</th>
<th>Degrees of Freedom</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>.12</td>
<td>3</td>
<td>17.10*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>.43</td>
<td>188</td>
<td>......</td>
</tr>
<tr>
<td>Total</td>
<td>.55</td>
<td>191</td>
<td>......</td>
</tr>
</tbody>
</table>

*Significant at the .05 level.

The results reported in Table V indicate that at least one of the differences between means is great enough to be statistically significant at the .05 level.

The summary table for the analysis of variance for non-dominant movement time of the four age groups is reported in Table VI.
<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sums of Squares</th>
<th>Degrees of Freedom</th>
<th>F Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>.03</td>
<td>3</td>
<td>8.03*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>.22</td>
<td>188</td>
<td>.......</td>
</tr>
<tr>
<td>Total</td>
<td>.25</td>
<td>191</td>
<td>.......</td>
</tr>
</tbody>
</table>

*Significant at the .05 level.

The results reported in Table VI indicate that at least one of the differences between means is great enough to be statistically significant at the .05 level.

The results reported in Tables III, IV, V, and VI indicate that between means of all four variables at least one difference is statistically significant. Since these values were found to be significant at the .05 level, a test for identifying areas of significance was selected.

Duncan's Multiple Range Test, as described by Clarke and Clarke,² was applied to the data to compare the mean scores and locate specific differences of reaction time and movement time at each age level. The results are reported in Table VII. The statistical significance for the test was set at the .05 level.

### TABLE VII

**DUNCAN'S MULTIPLE RANGE SCALE FOR DIFFERENCES BETWEEN MEANS FOR ALL GROUPS**

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Means</th>
<th>Mean Difference</th>
<th>Duncan Range Product*</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRT (N=48)</td>
<td>8 - 11</td>
<td>.27</td>
<td>.22</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>8 - 10</td>
<td>.27</td>
<td>.25</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>8 - 9</td>
<td>.27</td>
<td>.26</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>9 - 11</td>
<td>.26</td>
<td>.22</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>9 - 10</td>
<td>.26</td>
<td>.25</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>10 - 11</td>
<td>.25</td>
<td>.22</td>
<td>.03</td>
</tr>
<tr>
<td>DMT (N=48)</td>
<td>8 - 11</td>
<td>.14</td>
<td>.10</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>8 - 10</td>
<td>.14</td>
<td>.12</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>8 - 9</td>
<td>.14</td>
<td>.12</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>9 - 11</td>
<td>.12</td>
<td>.10</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>9 - 10</td>
<td>.12</td>
<td>.12</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>10 - 11</td>
<td>.12</td>
<td>.10</td>
<td>.02</td>
</tr>
<tr>
<td>NRT (N=48)</td>
<td>8 - 11</td>
<td>.28</td>
<td>.21</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>8 - 10</td>
<td>.28</td>
<td>.25</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>8 - 9</td>
<td>.28</td>
<td>.26</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>9 - 11</td>
<td>.26</td>
<td>.21</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>9 - 10</td>
<td>.26</td>
<td>.25</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>10 - 11</td>
<td>.25</td>
<td>.21</td>
<td>.04</td>
</tr>
<tr>
<td>NMT (N=48)</td>
<td>8 - 11</td>
<td>.14</td>
<td>.11</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>8 - 10</td>
<td>.14</td>
<td>.13</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>8 - 9</td>
<td>.14</td>
<td>.14</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>9 - 11</td>
<td>.14</td>
<td>.11</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>9 - 10</td>
<td>.14</td>
<td>.13</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>10 - 11</td>
<td>.13</td>
<td>.11</td>
<td>.02</td>
</tr>
</tbody>
</table>

*If the mean difference exceeds the range product value, the means are significantly different at the .05 level.

**Significant at the .05 level.
Examination of Table VII indicates that in the comparison of means between each age group of dominant reaction time, a statistically significant difference exists between ages eight and eleven, eight and ten, nine and eleven, and ten and eleven. The difference between means of the subjects eight and nine and nine and ten years old in dominant reaction time was not great enough to be statistically significant. Times improved consistently from age eight to age eleven.

There was a statistically significant difference in means of the dominant movement time between ages eight and eleven, eight and ten, eight and nine, nine and eleven, and ten and eleven. The difference between means of the subjects eight and ten and nine and ten in dominant movement time was not great enough to be statistically significant. The times improved from age eight to age nine, but the times were the same from nine to ten. The eleven-year-olds had a better score than all others.

There were statistically significant differences in means of the non-dominant reaction time between all ages except one. This exception was between ages nine and ten. Times improved consistently from age eight to age eleven.

There were statistically significant differences in means of the non-dominant movement time between ages eight and eleven, nine and eleven, and ten and eleven. The differences between means of the subjects eight and nine years old, eight and ten years old, and nine and ten years old were not great enough.
to be statistically significant in non-dominant movement time.

Times improved consistently from age eight to age eleven.

In all four groups the older subjects had a lower time than the younger subjects except for the nine and ten-year-olds' dominant movement times, in which case the times were the same. In each of the four groups the eleven-year-old subjects had a mean that was significantly better than the means of all other age groups.

The $t$-test as described by Lordahl was selected to determine the statistical significance between the dominant and non-dominant arm at each age level. In Table VIII $t$-ratios are reported in comparing dominant reaction times and non-dominant reaction times for each age group.

**TABLE VIII**

**MEANS, STANDARD DEVIATIONS, MEAN DIFFERENCES AND $t$ VALUES FOR DIFFERENCES IN REACTION TIMES**

<table>
<thead>
<tr>
<th>Age</th>
<th>Dominant Reaction Time</th>
<th>Non-Dominant Reaction Time</th>
<th>Mean Difference</th>
<th>$t$ Ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>8</td>
<td>.27</td>
<td>.03</td>
<td>.28</td>
<td>.04</td>
</tr>
<tr>
<td>9</td>
<td>.26</td>
<td>.05</td>
<td>.25</td>
<td>.05</td>
</tr>
<tr>
<td>10</td>
<td>.25</td>
<td>.05</td>
<td>.24</td>
<td>.05</td>
</tr>
<tr>
<td>11</td>
<td>.22</td>
<td>.05</td>
<td>.21</td>
<td>.05</td>
</tr>
</tbody>
</table>

*t of 2.02 required for significance at the .05 level.

3Lordahl, pp. 185-187.
Examination of Table VIII indicates that the t-ratio at each age level between dominant reaction time and non-dominant reaction time is not great enough to be statistically significant at the .05 level.

Although these mean differences were not great enough to be statistically significant, the eight-year-old subjects had a better time with their dominant arm. The nine, ten and eleven-year-old subjects had a better mean in reaction time with their non-dominant arm.

The t-test was also used to determine the statistical significance of differences between dominant and non-dominant movement times at each age level. In Table IX the t-ratios are reported in comparing dominant movement times and non-dominant movement times for each age group.

**TABLE IX**

MEANS, STANDARD DEVIATIONS, MEAN DIFFERENCES AND t VALUES FOR DIFFERENCES IN MOVEMENT TIMES

<table>
<thead>
<tr>
<th>Age</th>
<th>Dominant Movement Time</th>
<th>Non-Dominant Movement Time</th>
<th>Mean Difference</th>
<th>t Ratio*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>8</td>
<td>.13</td>
<td>.03</td>
<td>.14</td>
<td>.03</td>
</tr>
<tr>
<td>9</td>
<td>.12</td>
<td>.03</td>
<td>.14</td>
<td>.03</td>
</tr>
<tr>
<td>10</td>
<td>.12</td>
<td>.04</td>
<td>.13</td>
<td>.04</td>
</tr>
<tr>
<td>11</td>
<td>.10</td>
<td>.03</td>
<td>.11</td>
<td>.03</td>
</tr>
</tbody>
</table>

*A t of 2.02 required for significance at the .05 level.

**Significant at the .05 level.
Examination of Table IX indicates that the t-ratio between dominant and non-dominant movement time at each age level is great enough in each case to be statistically significant at the .05 level. For each age group the dominant arm had a better mean than the non-dominant arm in movement time.

The Pearson product-moment correlation coefficient as described by McNemar was calculated for all possible combinations of variables. This procedure was selected to determine the relationship between reaction time and movement time and also to determine the relationship between the dominant and non-dominant arms at each age level. The relationship between reaction time and movement time was determined by computing the correlation coefficient of the dominant and non-dominant arm at each age. Correlations of .29 and above are required for statistical significance at the .05 level. The computed correlation coefficients are found in Table X.

A statistically significant relationship existed between reaction time and movement time of dominant and non-dominant arms of the eight-year-old subjects. The correlations were .55 for the dominant arm and .36 for the non-dominant arm. The relationship was not great enough to be statistically significant between reaction time and movement time of the nine-year-olds. The correlations were .24 for the dominant arm and .15 for the non-dominant arm.

---

### TABLE X

**CORRELATION COEFFICIENTS BETWEEN REACTION TIME AND MOVEMENT TIME BY DOMINANCE AND AGE**

<table>
<thead>
<tr>
<th>Age</th>
<th>Group</th>
<th>DMT</th>
<th>NRT</th>
<th>NMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>DRT</td>
<td>.55*</td>
<td>.63*</td>
<td>.36*</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>.31</td>
<td>.72*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td></td>
<td>.36*</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>DRT</td>
<td>.25</td>
<td>.74*</td>
<td>.27</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>.21</td>
<td>.56*</td>
<td>.15</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>DRT</td>
<td>.44*</td>
<td>.68*</td>
<td>.30*</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>.47*</td>
<td>.68*</td>
<td>.30*</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>DRT</td>
<td>.20</td>
<td>.30*</td>
<td>.15</td>
</tr>
<tr>
<td></td>
<td>DMT</td>
<td>.22</td>
<td>.63*</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>NRT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the .05 level.

As did the eight-year-old subjects, the ten-year-old subjects showed a significant relationship between reaction time and movement time. The correlations were .44 for the dominant arm and .30 for the non-dominant arm. The relationship was not great enough between reaction time and movement time of the eleven-year-old subjects for statistical significance. The dominant arm had a $r$ of .20 and the non-dominant had a $r$ of .13.
All age groups showed a statistically significant correlation between reaction time of the dominant and non-dominant arms. The eight-year-old subjects had a correlation of .63, the nine-year-olds .73, the ten-year-olds .68, and the eleven-year-olds .80. Also, all age groups showed a statistically significant correlation in dominant and non-dominant movement time. The eight-year-old subjects had a correlation of .71, the nine-year-olds reported a correlation of .55, the ten-year-olds had a correlation of .68, and the eleven-year-old subjects had a correlation of .63.

Summary of the Findings

The results of the analyses indicate the following pertinent findings relative to the data.

1. Reaction time for the dominant arm was significantly different between ages eight and eleven, eight and ten, nine and eleven, and ten and eleven with times improving consistently from the eight-year-olds to the eleven-year-olds.

2. Reaction time for the non-dominant arm was significantly different between ages eight and eleven, eight and ten, eight and nine, nine and eleven, and ten and eleven with times improving consistently from age eight to age eleven.

3. Movement time for the dominant arm was significantly different between ages eight and eleven, eight and nine, nine and eleven, and ten and eleven. The eleven-year-olds' times
were superior, for the nine and ten-year-olds the difference was not significant, and the eight-year-olds had the poorest times.

4. Movement time for the non-dominant arm was significantly different between ages eight and eleven, nine and eleven, and ten and eleven with times improving consistently at each age level.

5. Reaction time between dominant and non-dominant arms was not significantly different at any age level.

6. Movement time between dominant and non-dominant arms was significantly different at each age level.

7. The correlation between reaction time and movement time of the dominant arm was great enough to be statistically significant at two age levels, eight and ten. These correlations were .55 and .44, respectively.

8. The correlation between reaction time and movement time of the non-dominant arm was great enough to be statistically significant at two age levels, eight and ten. These correlations were .36 and .30, respectively.

9. The correlation between dominant reaction time and non-dominant reaction time was great enough to be statistically significant at each age level. These correlations ranged from .63 to .80.

10. The correlation between dominant movement time and non-dominant movement time was great enough to be statistically significant at each age level. These correlations ranged from .56 to .72.
Although the relationship between reaction time and movement time of the eight and ten-year-old subjects was statistically significant, the correlations were relatively low. The correlations between the dominant and non-dominant arms of all age levels for both reaction time and movement time were statistically significant, and these correlations were higher than those relating reaction time and movement time. In every group the times improved with age. Also, for both reaction time and movement time the eleven-year-old subjects had a significantly better mean than each of the other age groups.
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate the reaction time and speed of movement of the dominant and non-dominant arms of elementary-school boys and girls. The 192 children were arranged in four groups, according to age, with forty-eight subjects in each age group from eight through eleven years. Each subject performed eight trials of the task with each arm and the mean of the eight trials was used in the analysis of the data.

The apparatus was designed specifically to measure reaction time and movement time. It consisted of two clocks, calculated to the nearest one-hundredth of a second, two high speed photo-electric relay units, a stimulus light, a control switch, and a reaction time button. These instruments were mounted on a plywood platform twenty-seven inches from the floor. A light-weight plywood handle was held by the subject to make sure the photo-light beam was broken by the hand in measuring movement time.

A test to measure simple reaction time and speed of movement was administered to each subject using the test instrument previously described. The tests were administered at Cannon Elementary School, Grapevine, Texas, during the school day. All testing was completed during the month of May, 1971.
The testing began with the lowest age group, and only one subject was in the testing area at a time. Two practice trials were allowed each subject after a complete explanation and demonstration of the task procedure. Half of the subjects began the testing with the dominant hand, and half of the subjects began with the non-dominant hand.

Each subject was given eight trials with the dominant hand and eight trials with the non-dominant hand. The score for each trial was recorded to the nearest one-hundredth of a second.

The means of the eight trials were computed and the data were organized in such a manner to be treated statistically. The level of significance was set at the .05 level for all computations. An analysis of variance was computed to determine if significant differences existed between means. Duncan's Multiple Range Test was selected to identify areas of significance between ages. The t-test was used to determine the significance of the differences between means for dominant and non-dominant arms in both reaction time and movement time for each age level.

The Pearson product-moment correlation was computed to indicate the relationship between reaction time and movement time of all ages. This measure was also computed to indicate the relationship between dominant and non-dominant reaction time and dominant and non-dominant movement time of all ages.
Conclusions

The findings would seem to warrant the following conclusions concerning reaction time and movement time of the dominant and non-dominant arms of elementary-school children:

1. Both reaction time and movement time improve consistently from ages eight to eleven.

2. Eleven-year-olds perform better in skills involving reaction time and movement time than do children ages eight through ten.

3. Youngsters ages eight through eleven perform equally well with either the dominant or non-dominant arm in skills involving reaction time.

4. Youngsters ages eight through eleven perform better with the dominant arm than the non-dominant arm in skills involving speed of movement.

5. The relationship between reaction time and movement time, though statistically significant in two of the four ages, is relatively low and not great enough for predictive purposes.

6. There is a positive relationship between the dominant and non-dominant arms in both reaction time and movement time for elementary-school children.

In comparing the means between reaction time and movement time of the dominant and non-dominant arms this study indicates that these variables are slowly improving functions of age in elementary-school children.
Recommendations

It is recommended that this type of study be performed on an older age group to see if reaction time and movement time continue to improve.

Also it is recommended that a more complex task to measure reaction time and movement time be used with the possibility that it may produce a greater difference between dominant and non-dominant arms.
Appendix A

Reaction Time - Movement Time Tester

A - 110 volt micro, button-type, off-on switch
B - Photo electric relay unit
C - Photo electric relay unit
D - Reaction time clock
E - Movement time clock
F - Stimulus light
G - Control switch
H - 60 watt light bulb
I - 60 watt light bulb

*The subject will stand at Position A while being tested.
APPENDIX B

HAND PREFERENCE TESTS

1. Place the tennis ball in front of child. Ask him to pick the tennis ball up and go about ten feet away. Ask child to THROW ball to you.

2. Place the rubber hammer in front of child. Ask him to HAMMER on the table as hard as he can five times.

3. Place tooth brush in front of child. Ask child to show you how he BRUSHES his teeth. Do not allow child to put the brush in his mouth.

4. Place the comb in front of child. Ask him to show you how he COMBS his hair.

5. Ask child to go to classroom door and TURN the doorknob.

6. Give child a piece of paper and a pencil. Ask him to WRITE the numbers 1, 2, 3, and 4.

7. Ask child to ERASE the last number.

8. Place scissors in front of child. Ask him to CUT OFF the part of the paper with numbers written on it.

9. Ask child to STAPLE two pieces of paper together.

10. Ask child to HAND the stapler back to you.

The hand used by the subject for each activity was recorded. The hand used the majority of the time was considered the dominant hand. If no dominance could be determined the subject was rejected.
BIBLIOGRAPHY

Books


Articles


Miles W. H., "Correlation of Reaction and Coordination Speed with Age in Adults," American Journal of Psychology, XLIII (July, 1933), 377-391.


Unpublished Materials
