HANDEDNESS DIFFERENCES
IN WRITING SPEED
AND THEME LENGTH AND EVALUATION

by

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required standard

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April, 1961
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Date April 26, 1961.
HANDEDNESS DIFFERENCES IN WRITING SPEED
AND THEME LENGTH AND EVALUATION

ABSTRACT

All the evidence contained in the investigation of 722 junior high school students points to the fact that there is no connection between the speed of writing and handedness; between the amount of written material produced in 5-minute themes and handedness; and between the effects of writing on subjective evaluations of 5-minute written themes and handedness. The figures show that the incidence of handicap in writing is approximately the same for both right- and left-handed groups.
ACKNOWLEDGMENT

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She is grateful to the seven hundred and twenty-two junior high school students who acted as subjects for the study, and to those members of the Vancouver school system responsible for making the subjects available: Dr. R. F. Sharp, Superintendent of Schools; Dr. D. B. MacKenzie, Assistant Superintendent of Schools; Dr. S. A. Miller, Director of the Department of Research and Special Services; the principals of five high schools: Mr. L. E. Meadows (Lord Byng), Mr. A. Webster (Killarney), Mr. V. A. Wiedrick (Kilsilano), Mr. K. A. Waites (Templeton), Mr. A. W. Hyndman (David Thompson); and the Vice-Principal in charge of the junior division at Lord Byng, Mr. G. Harris.

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INTRODUCTION

Tools and positions intended for the convenience of right-handed persons impose adjustment problems upon the left-handed individual who does not choose to change his hand.

Weapons and machines in heavy industry with controls intended for right-handed use offer the greatest physical hazard to the left-handed person. In emergency, he may forget to apply the carefully learned routines with his non-preferred hand and stretch his master hand across the weapon or machine to operate the controls. His safety limits are thereby seriously lowered.

In manual skills involving innocuous tools, the left-handed person's adjustment problems are less crucial. In striving for competence he need only find tools designed for his use and suitable positions for himself and the material he is working on.

In fencing and in baseball he is at a positional advantage over his right-handed opponent, who is used to defending himself against persons using the right hand. In golf, he need only have clubs manufactured for left-handed use to compete with the right-handed person on a basis of equality.

Tools and equipment designed for left-handed use are in increasing supply. The most serious manual problem
of the left-handed person is correspondingly tending to disappear.

Now that the straight pen and the fountain pen have been largely replaced by the non-directional ball-point pen, the left-handed writer need not have a writing tool problem. With proper instruction in the placement of his notebook in reverse position to that of the right-handed writer, and in the placement of his arm in a position parallel to the centre line of his notebook, he need be at no positional disadvantage in writing. The direction of the script is the only aspect of the writing environment that is not subject to change for the convenience of the left-handed writer.

The direction of the script in our culture imposes upon the left-handed writer operating with reverse arm and page position the necessity of writing towards his body rather than away from it, a natural tendency to a back-handed slant in his writing, or a reversal in pressures on the up-strokes and down-strokes of the letters.

Lacking or ignoring previous positional instruction, or striving for the usual slant, or avoiding hand shadow, the left-handed writer may develop idiosyncracies in position that cut down on the speed and quality of his writing.

This study ignores the idiosyncracies of left-handed writers and focusses upon the effectiveness of their writing efforts in comparison with matched right-handed writers.
SECTION I

THE PROBLEM

This study concerns itself with a comparison of performance by right- and left-handed subjects in handwriting, with reference to speed, productivity, and marks obtained in subjectively evaluated handwritten themes.

Specifically, the hypotheses are as follows:
1. Handedness affects the speed of writing.
2. Handedness affects the production of words in essay-type themes.
3. Handwriting affects subjective evaluations of the written themes of
   a. right-handed subjects.
   b. left-handed subjects.

The rationale of the study rests on the assumption that left-handers are a handicapped group. This study attempts to isolate specific aspects of disadvantage to the left-hander when using writing as a means of communication in examination-like circumstances.
The causes of left-handedness have long been of interest. Argument continues as to whether it is inherited, acquired or a combination of both.

In keeping with the genetic bias of the era, studies made early in the century (Parsons, 1924) tend to support heredity as the primary cause of left-handedness. Later theories have stressed functional factors. Blau (1946) sees left-handedness as a symptom of infantile psychoneurosis, a deviation from a culturally determined laterality. A single illustration (Wheeler, 1960) that appears to lend support to the theory of negatavistic response to frustration has been supplied by a four-year-old child whose handedness changed during hospitalization after an emergency tracheotomy operation.

Hewes (1948) considers that there is a fairly sound genetic foundation for handedness. As evidence for considering "beyond any reasonable doubt the existence of an anatomical basis for functional handedness" he reports on a study in dermatoglyphics (Cromwell and Rife in Hewes, 1948), in which was found significant correlation of finger- and hand-print pattern with laterality. He points out, however,
that this study does not answer the problem of the priority of handedness over hemisphere laterality.

In a further study on dermatoglyphics and mirror imaging, Rife and Cummins (1943) found that identical twinning does not seem to be, as formerly believed, a factor in handedness. Mirror imaging in dermatoglyphics occurred no more frequently in monozygotic twins than in random pairs of unrelated individuals, siblings, or fraternal twins.

Baker (1945) points out that "lateral dominance" is the term now generally used to indicate hand preference, but that it also includes reference to eye, foot and ear preference and general bodily dominance. However, lateral dominance is by no means consistent in all its aspects within the individual. Clark (1957) established a connection between foot and hand preference, between ear and eye, but none between eye and hand. Correlations between various aspects of dominance have frequently been mistaken for causal relationships: Individuals are left-handed because they are right-brained and vice-versa; they are left-handed because they are left-eyed.

Now, even the earlier assumption that one side of the brain is dominant in speech functions, and that side the one contra-lateral to the preferred hand, is questioned as to its universal application. Certainly, it is difficult to prove in view of the lack of studies of left-handed subjects with brain lesions. Clark (1957) states that:
Recent studies have necessitated a modification of some of the earlier extreme statements on the subject of brain dominance and speech. Two points on which the earlier statements have been modified are: first the statement that the area controlling speech is always on the contra-lateral side to the preferred hand; and second that the minor hemisphere is useless or completely unused in speech functioning.... It is impossible to state whether a given person is left- or right-brained until a cerebral lesion occurs. (p. 29)

As yet, no diagnostic instrument has been found to measure lateral dominance 'in toto', and indeed this may be impossible in view of the asymmetrical nature of dominance. The Van Riper Critical Angle Board is the most popular diagnostic tool for measuring laterality but its effectiveness is in question. It would seem (Clark, 1957) that intelligence as well as laterality is a variable in the test.

Problems remain, then, not only in establishing the causes of left-handedness, but even in assessing the very nature of dominance.

A largely unexplored area in the etiology of handedness is that of environmental factors in utero. Rife (1943), in further studies on handedness and dermatoglyphics in twins, found that circumstances in utero modify the expression of handedness in that members of the pair differ, but that twins genotypically strongly right- or left-handed show no interpair differences in handedness.

The incidence of left-handedness in individuals born in breech position has not been investigated. The relationship between positional and developmental factors
of the foetus might be involved in predispositions to laterality.

Any new theory of the causation of handedness is likely to involve an interacting pattern of influences in the holistic manner. Clark (1957) has one of the latest statements to make on the subject:

The position may be summed up by saying that genetic studies have revealed that the development of handedness preference has a hereditary basis.... Few would deny, however, that factors other than genetic help to determine whether any particular individual will be right- or left-handed.... The environmental variants probably account for the slow progress which has been made in formulating an adequate and satisfactory theory concerning the actual mechanism of inheritance. (p. 17)

Perhaps the hereditary influence will be found to be social rather than genetic.

The literature abounds with speculation and study on the problem of conversion. Those with a genetic and neurological bias have tended to resist efforts at changing handedness because of the possible psychological by-products of the change: stuttering and other ineffective behavior patterns. Blau (1946) speculates that the dominant hemispheric control is the end product of the hand used, and that change of hand need not result in neurological chaos. Garrison (1950) supports this view:

A reversal in handedness in writing seldom results in stuttering.... In the schools of Elizabeth, New Jersey, a campaign to "cure" left-handedness was instituted. In the course of four years, left-handedness was reduced from 250 cases to 66 cases and not a single case of defective
speech resulted.... Had these 66 children been forced to use their right hands many would perhaps have shown nervousness.... Persistently antagonistic methods used to effect a change in handedness may cause various types of disorders when nervous instability is present. (p. 344)

Burt (1954), basing his judgment on the New Jersey experiment, feels that consistency in the retraining of left handers who know and accept that they must write with their right hands may obviate the necessary appearance of nervous symptoms after a change of the writing hand.

Writing has borne the brunt of experimentation in changing handedness, probably because of the strong tendency to conformity in the school situation. Inconsistency has been general, however, both as to time and system of instituting the change. Sometimes the change is self-imposed by a child who no longer wants to be different. There are instances of temporary conversion and ultimate reversion, with no final feeling of victory over the problem. Each left-handed writer and changed-to-right-handed writer has a unique writing history. Therefore, according to Clark (1957):

**Comparisons between groups of left-handers should be regarded with caution, while comparisons between right- and left-handed groups as far as writing is concerned are actually dangerous. It must be admitted that there is some truth in the suggestion that left-handers are bad writers. It is, however, a generalization with only a certain amount of truth in it, and for that reason all the more dangerous, since frequently wrong conclusions are drawn from it. By no means all left-handers are bad writers.... The majority of those writing with the left hand produce writing which is either neat or speedy, but seldom both; this is admittedly a failing not confined to them. They do, however, suffer more from fatigue than those using the right hand. (p. 82)**
The fatigue factor doubtless arises, not alone from faulty or inadequate teaching, but also from the direction of the script in our culture. Mirror writing is the only complete equivalent of right-handed writing techniques. Outside the diary it is an impractical adaptation. Placing the page in the exact opposite position to that of the ideal placement for the right-hander is the next best solution, using a back-handed slant that allows free arm movement, with the arm parallel to the page. In this way, the left hander can avoid hooks, shadows and excessive fatigue. He still, however, has to write towards the body, rather than away from it. While writing systems of the world vary as to direction, left to right, right to left or alternating; or up and down on the page; the one we are concerned with uses the left to right direction in such a way as to be most convenient for the right-handed person, and to allow him to express his ideas in symbols easily perceived by the reader.

Script itself imposes no particular orientation. We can be taught to read from various angles. Arabs have been taught to read the Koran, because it is in such short supply, from all four sides. What we would call mirror writing is used in Arabic and in Hebrew. Do left-handers find these languages easier to read and write than right-handers? Does the plane of the eye affect reading and writing proficiency? Japanese pilots have been reported (Hewes, 1949) to have had difficulty in spotting danger from the sides. Perhaps left-eyed persons perceive differently from right-eyed persons.
Analyses of protocols of such projective tests as the Rorschach, for example in the use of white space, might throw light on these questions of differential perception on the basis of laterality. However, we may assume (Hewes, 1949) that all cultures have been dominated by people who are dextral in their manual and probably their visual skills, including those cultures where writing is in use.

If the left-hander is not taught to use his right hand in writing, he clearly should be taught how to use his left hand most effectively. Garrison (1950), acknowledging indebtedness to Hildreth (1937, 1947) makes the following suggestions:

1. The page should be slanted so as to form an angle of 35 degrees, or as much as 45 degrees, with the desk. The paper and arm should be at about the same slant.

2. An exaggerated downward slant of the top line of the paper should be permitted, so as to furnish the child with increased visibility. The child should not be required to imitate the positions and movements of his right-handed neighbors.

3. In teaching the left-hander, the teacher should vary the method to suit the special needs of the child; however, any tendency to twist the hand should be corrected at the very beginning. The practice periods should be short for the left-hander.

4. The teacher may find it desirable to have the child practise print-script writing in the first stages.

5. Large arm movements, rather than finger movements, should be encouraged during the beginning stage. Blackboard work may be used to good advantage at this time.
6. The entire child is involved in the writing act. His emotional needs, his maturational level, his educational achievement, and his motives are important. (p. 154)

Advice from Hildreth (1936) focusses on writing slant and hand position:

The left-handed person should be encouraged to write a back-hand style.... The teacher should encourage normal hand pronation with the fingers extended towards the top rather than to the bottom of the page. (p. 542)

Burt's recommendations (1954) are oriented towards skilful retraining of the left-hander to enable him to use his right hand in writing.

The director of education in London, Ontario, (Lucas, 1956) himself a left-hander, has been interested for many years in the problems of left-handed children "who live in school-rooms and in a world where almost everything is made for and adapted to the needs of the majority". He disapproves of conversion, considering that this is likely to result in tension, resistance and embarrassment. He sees the problem not to be one of changing hands but one of helping children become graceful left-handers. In his recommendations for the supervision of left-handed writers he adds to the advice of Garrison and Hildreth in that he warns teachers against accepting for a left-hander any one-armed writing chair designed for the right-hander. He also makes a practical suggestion to teachers to help them develop empathy with their left-handed pupils: Every right-handed teacher should try to cut with scissors and to write with
the left hand in order to understand her left-handed pupils. If this were done, he thinks, teachers would no longer require their left-handed pupils to cut circles counterclockwise, but would realize that clockwise is the normal procedure for left-handers.

The Vancouver school system issues two-page brochures on the left-handed writer to primary teachers, emphasizing correct positioning of the paper, and warning against conversion. These instructions were first given to primary teachers in 1954.

In recent years, in Sweden, England and the United States, investigations have been undertaken to measure to comparative speed and quality of left- and right-handed writing.

A three-year study in Sweden (Trankell, 1956) failed to uncover statistically significant differences in speed and quality of left- and right-handed writers, but emphasized the influences of conversion on the writing:

The analyses indicate that the left-hander's choice of writing hand influences their writing proficiency. For the speed of writing this influence is not great enough to be statistically discernable. As regards the quality of the handwriting, however, the left-handers who use the same hand from the beginning of their school life are found to achieve a higher standard than those left-handers who succeeded in changing with practice to right-handed writers. (p. 101)

A study of right-handed answer sheets and left-handed testees conducted by Gordon (1958) resulted in the finding of a significant mean at the .05 level between marks
obtained by left- and right-handed naval recruits on a naval clerical test. The right-handed insert answers sheets were considered to be a factor accounting for the differences.

An experimental investigation was undertaken in the Kingston College Clinic, in England, by Smith and Reed (1957) on the relative speeds of left- and right-handed writers. In this study, 70 pairs of children, from 6 schools, were used as subjects, the right-handers being roughly paired with the left-handers as to school, age, and with the exception of one school, sex. No attempt was made to establish degree of laterality, history of conversions, or the intelligence of the subjects. Where there was a choice of subject, the desired number was taken in alphabetical order of surnames. No statistically significant differences in speed were found either for the total of group differences or for differences considered school by school. A serious defect of this experiment is the disregard of the variable of intelligence, since the sample is not large enough to pre-suppose normal distribution.

The most recent and comprehensive study of left-handedness in its many ramifications, including handwriting, has been made by Clark, who reports (1957) on an investigation of the laterality characteristics of 330 children, 18 of whom were left-handed. Clark's writing test included investigation of both speed and quality, using the same sample of writing, executed in two minutes, for both purposes.
Each of the 18 left-handers was paired with a right-hander on the basis of classroom, sex, and intelligence. A similar paired group was established of 14 right-handers who had been converted, or who showed strong sinistral tendencies, with 14 right-handers who showed no left-handed tendencies.

The results of her test do not support the hypothesis that left-handers are slower writers than right-handers of the same sex and intelligence, taught in the same class, although the means for both the left-handed writers and for those with left-handed tendencies were lower than the means for the corresponding right-handers. The results of her test do not support the hypothesis that left-handers produce writing of a poorer quality than the corresponding right-handers. Differences were not apparent between right- and left-handers in sacrificing speed to quality or quality to speed.

Clark concludes that if differences do exist in the speed and quality of right- and left-handed writing, an investigation on a much larger scale than hers would be required for confirmation of differences.

The left-hander's effectiveness as a writer would seem, from all these recently published studies, to be equivalent to that of a right-handed writer. In view, however, of the lack of rigorous control in matching the pairs in one relevant study (Smith and Reed, 1957) and of the small sample in another (Clark, 1957), further
investigation of handwriting differences in right- and left-handed subjects is continued in this present study. The matching of the pairs will be more carefully controlled than in the study made by Smith and Reed; the sample will be much larger than in the study made by Clark.

The purpose of this present study is to investigate the differences between the right- and left-handed groups in speed of writing, and in their theme-writing effectiveness, both as to number of words produced and as to marks obtained in subjective evaluations of the themes.
SECTION III

METHOD

1. Subjects and bases of matching pairs

The subjects of this study were grade VII, VIII, and IX pupils in the Vancouver schools. The investigator, acting as a substitute teacher, was called to five widely separated schools, thereby obtaining a representative sample of the Vancouver junior high school population. The schools were Kitsilano, Templeton, David Thompson, Lord Byng and Killarney. Twenty-three classes were tested, 11 of which were all girls, 10 all boys and 2 mixed.

Of the 722 subjects tested, 88 were left-handed. Of the 368 girls tested, 38 were left-handed; of the 354 boys tested, 50 were left-handed. Three left-handed girls and one left-handed boy were left out of the sample because of physical condition or lack of information on their intelligence.

The 84 qualifying left-handers were matched with 84 right-handers on the bases of age, grade, sex, school, years in Canada not less than five, strength of handedness (those right-handed writers who showed signs of left-handedness by erasing with their left hands, or who said
they had been changed from left-handedness, were not included in the control group), and intelligence. All information, except on intelligence, was obtained from the subjects' answers to a questionnaire written on the blackboard. Intelligence ratings were obtained in the school office files. The latest rating entered in the files was taken. In all cases but one, the ratings were from Otis group tests; the exception was a high rating left-handed subject on the basis of the Stanford-Binet, who was paired with his highest rating left-handed classmate, considerably lower numerically on the basis of the Otis.

2. The tasks

Each class was met by the investigator at the beginning of a school period, and given a friendly briefing on the part they were to play as subjects in a research project. All were supplied with foolscap paper, lined on both sides, and with ball-point pens.

For the speed test they were given the following instructions:

I want to see how fast you can write. When I give the signal, write one two three four etc., as far as you can go until I tell you to stop in 100 seconds. You use no commas, no dashes, just words.

A demonstration of the writing was made at the board and then the signal to begin was given.

After completion of this test, to allow a change
of pace and muscle relaxation, they were instructed to answer the questionnaire, using the same side of the paper for their answers.

After plenty of time had been given for all to finish the questionnaire, the essay-type test was introduced as follows:

OK. Turn over your page. Do not put your name on this side. When these papers are marked, the examiners are not supposed to know whose they are. I want to see what kind of a piece you can write about Vancouver in five minutes. Write as if you are promising to show the city to a friend from out of town. Start like this: If you come to Vancouver I will show you......

The introduction was written on the blackboard for all to see; the subjects were then told to begin. Ten seconds before the end of five minutes, they were instructed to finish their sentence and stop.

3. Treatment of data

a) Speed test

Scoring was on the basis of the letters used in writing "one two three four etc", as far as possible in 100 seconds. For example, "one two" would be scored 6; "one... twenty" would be scored 112, the total number of letters used in writing the numbers from one to twenty.

The experimental design chosen was that of matched pairs of right- and left-handed subjects, with handedness the independent variable and writing speed the dependent
variable. Other relevant variables (age, grade, sex, intelligence, etc.) are assumed to be controlled by the careful matching of the pairs.

The differences in scores of the matched pairs of right- and left-handed subjects were examined for significance by the t test with $83 \text{ df}$ at the .05 level of confidence.

b) Productivity

Scoring was on the basis of the length of the production in the 5-minute written themes.

The experimental design chosen was that of matched pairs of right- and left-handed subjects, with handedness the independent variable, and amount produced on the theme the dependent variable. Relevant personal variables, as in the speed test, were controlled by the careful matching of the pairs. To eliminate word length and size of writing as variables, the hand-written themes were not used either for word counting or line counting. Instead, the written themes were typed on the same machine, set for uniform line length, and these copies were used for measuring productivity. The number of typewritten lines of each theme was taken as a score.

The scores of the copied themes of the matched pairs of right- and left-handed subjects were then examined on the basis of Right Better Then Left (more lines), or
Right Worse Than Left (fewer lines).

The difference between Right Better Than Left and Right Worse Than Left was examined for significance by a Chi square test of association, with 1 df at the .05 level of confidence.

c) Subjective evaluation of written and typed themes

Evaluation of the themes was on the basis of an eleven point scale, 0 to 10, and was made by four judges, each one a teacher and three with one or more university degrees. Each judge preceded his marking by reading a list of qualities commonly affecting subjective judgment of school compositions (Remondino, 1959): Readability, aesthetic arrangement, appearance, spelling, syntax, organization of ideas, wealth of ideas, adequacy of thoughts, comprehensiveness, conciseness, language usage, style, originality, maturity and imagination.

When he had read this list, the judge was instructed to mark the theme on the basis of his global impression of its value. Themes were judged twice by each marker, once in the original handwritten state, and once in the typewritten facsimile. At least four days elapsed between the two marking sessions of each judge. Two of the judges marked the typewritten versions first, two the written versions.

The experimental design chosen was that of matched pairs of themes, one the original hand-written theme and
the other the typewritten copy of the original theme. Since all errors in spelling, punctuation, etc., in the original written theme were preserved in the typewritten copies, only readability (the effect of the quality of the writing on the judges) remains as an independent variable. The dependent variable is the subjective evaluation of the theme in both versions, written and typed.

The marks of the written and typewritten versions of each theme by each judge were inspected for "Better Typed" or "Worse Typed", in two categories:

a. for the themes of the right-handed subjects
b. for the themes of the left-handed subjects

In each category, the difference between "Better Typed" and "Worse Typed" was examined for significance by the Chi square test of association, with 1 df at the .05 level of confidence.
.SECTION IV

RESULTS

1. Speed test

Variances in the speed scores of the right- and left-handed writers were not found to be significantly different on the basis of the F test, so that the use of the statistic t with 83 df at the .05 level of confidence seemed appropriate. Distribution of data is assumed to be normal.

No statistically significant differences were found between the mean right-handed writing speed of 173.3 and the mean left-handed writing speed of 167.9.
TABLE 1
SPEED SCORES

<table>
<thead>
<tr>
<th></th>
<th>Mean score</th>
<th>df</th>
<th>Variances</th>
<th>F</th>
<th>Standard Error</th>
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<tr>
<td>Right Handed</td>
<td>173.3</td>
<td>83</td>
<td>1104.2</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1.187</td>
<td></td>
<td>4.9</td>
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<tr>
<td>Left Handed</td>
<td>167.9</td>
<td>83</td>
<td>930.2</td>
<td></td>
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2. Productivity

When the matched pairs of right- and left-handed subjects were compared for productivity on the basis of which of the pair had the highest line score on the typewritten facsimiles of the original themes, it was found that Right Better Than Left occurred 43 times; Right Worse Than Left occurred 32 times. This is not a significant difference in terms of the Chi square test of association, with a df of 1 at the .05 level of confidence.

3. Subjective evaluations of written and typed themes

On the basis of the scores allotted by four judges to the written themes and to the typewritten facsimiles, judged at least four days before or after the written themes,

a. 95 judgments were in favour of Right Better Typed and 105 judgments were in favour of Right Worse Typed;

b. 111 judgments were in favour of Left Better Typed and 98 judgments were in favour of Left Worse Typed.
<table>
<thead>
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<th></th>
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<th>Left-handed</th>
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<td>Better Typed Than Written</td>
<td>95</td>
<td>111</td>
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<tr>
<td>Worse Typed Than Written</td>
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<td>98</td>
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<td>$\chi^2$</td>
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</tbody>
</table>
Differences between the typed and written versions, on the basis of the Chi square test of association with 1 df at the .05 level of confidence were not significant in either the right-handed group or the left-handed group. Therefore it is pointless to compare the results of the right-hand category with those of the left-hand category, even though the right-handed group got more judgments in favour of "Worse Typed" and the left-handed group got more judgments in favour of "Better Typed".
SECTION V

DISCUSSION AND CONCLUSIONS

The null hypothesis could not be rejected in any area of this study, whether in speed, productivity, or in the influence of handwriting in subjectively evaluated themes written in five minutes.

These results are in keeping with those of the most recent similar studies (Smith & Reed, 1957; Clark, 1957).

The lack of statistically significant differences between right- and left-handed subjects in the aspects of handwriting considered in this study does not exclude the possibility that some left-handed writers (and indeed some right-handed writers) are at a disadvantage in the examination situation because of the speed or quality of their handwriting.

In speed, the scores in both groups varied from approximately 80 to approximately 240. That is, under the pressure of speed, the fastest writers produced about three times as many letters as the slowest. The number of letters he can produce in 100 seconds may or may not predict an individual's capacity for finishing examinations of one to three hours duration. There is the possibility, however, that slow writers are not able to write enough to express
their knowledge of a subject in the time allotted in a given examination.

The fatigue variable is probably negligible in a 100 second or 5 minute test. A longer period of testing, for example, the three hour period of the university examination, would be appropriate for studying the relationships between fatigue and word production or fatigue and handedness.

The spread of scores from 1 to 11 in line productivity in the themes is indicative of wide individual differences and worthy of study apart from the aspect of handedness, which was not found to be a significant influence on production.

While the differences in subjective evaluations of written and typed themes were not found to be statistically significant in this study, the reversal in trend between the judgments on right- and left-handed groups seems worthy of note. The judges liked the themes of the right-handers better when they were in the original hand-written state; they liked the themes of the left-handers better when they were copied on the typewriter. This reversal may be attributed statistically only to chance and cannot therefore be a base from which to draw conclusions.

While the results of all three tests show the right-handed group at a slight advantage over the matched left-handed group, chance factors have not been ruled out as the sole determinants of this apparent trend.
The conclusion in the study made on roughly matched pairs (Smith & Reed, 1957) that there is no significant difference between the right- and left-handed groups in the speed of writing is confirmed in this study, made with carefully matched pairs.

The conclusion in the study made on a small sample of 18 pairs (Clark, 1957) that there is no significant difference between the right- and left-handed groups in either the speed or quality of writing is confirmed in this study, made on a larger sample of 84 pairs.

The over-all statistical results of this study do not establish significant differences between right- and left-handed groups in any of the areas of handwriting under investigation. If differences exist between right- and left-handed writers in speed and quality of writing, they do not become apparent in one- to five-minute tests.
SECTION VI

SUMMARY

The handwriting of 84 pairs of left- and right-handed junior high school students was examined to find out if the left-handers were at any disadvantage in speed, productivity, or the quality of readability.

The experimental design of matched pairs was used throughout. For speed, the pairs were matched right- and left-handers, with the amount written in one hundred seconds the dependent variable. For productivity, the pairs were matched right- and left-handers, with the length of the typed facsimiles of the written themes as the dependent variable. For the quality of readability, the pairs were hand-written themes and their typed facsimiles, with readability the dependent variable.

The null hypothesis could not be rejected in any of the three aspects under investigation of writing and its relationship to handedness.
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